INTERNATIONAL ASSISTANCE: WORKING TO COORDINATE THE AID

Since the Chernobyl accident in 1986, an increasing number of Western organizations and companies have offered to help improve the safety and operation of Soviet-designed nuclear plants. Initially, some of this assistance was slowed or stalled because of coordination problems and liability concerns. The coordination problem has been largely overcome, and progress is being made with respect to third-party liability.

The Group of Seven major industrialized nations—the United States, the United Kingdom, France, Germany, Canada, Japan and Italy—have adopted a coordinated policy on aid. The countries of Eastern Europe and the former Soviet Union have moved to protect Western companies installing safety equipment at Soviet-designed reactors against damages in the event of an accident. Russia, Ukraine, Lithuania, Armenia and the four Eastern European countries with Soviet-designed nuclear plants—the Czech Republic, the Slovak Republic, Hungary and Bulgaria—are signatories to the Vienna Convention, which ensures that the responsibility for damage caused by a nuclear accident is channeled to the plant operator. In addition, Bulgaria, the Czech Republic, the Slovak Republic, Hungary, Lithuania, Ukraine and Russia all have enacted nuclear laws containing liability provisions.

However, many Western contractors and suppliers remain unwilling to install safety-related equipment that directly affects Russian and Ukrainian plants' reactor operation because of the lack of full legal and financial protection in the event of an accident.

A major challenge now facing both East and West is the transition from government assistance programs to commercial relationships.

G-24 Initiative and the Nuclear Safety Account

Creation of Nuclear Safety Working Group

In an attempt to impose order on the dissemination of aid to the East, the Group of 24 (the member states of the Organization for Economic Cooperation and Development, plus Turkey), the OECD's Nuclear Energy Agency (NEA), the Commission of the European Communities (CEC)—now the Commission of the European Union—and the International Atomic Energy Agency (IAEA) met in Brussels in 1991. As a result, the G-24 created a Working Group on Nuclear Safety, and asked the CEC to establish a secretariat to act as a clearinghouse, setting up meetings and collecting information.

The G-24 nuclear safety working group met in February, July and September 1992, and at the September meeting it set up a 10-country executive steering committee with representatives from both East and West. The working group, which brought together aid donors and recipients, established several technical working groups to address specific issues such as improvements to VVER-440 Model V230s and RBMKs, training, and regulation. In addition, the working group asked the secretariat—the Nuclear Safety Assistance Coordination Center—to improve the coordination of assistance programs.

Setting Up Database. To help it keep track of the bilateral aid programs, as well as the activities supported by the multilateral fund, the G-24 Nuclear Safety Assistance Coordination Center relies on a special database that it created with the IAEA. According to the database, the G-24 nations have funded or proposed to fund more than 1,000 nuclear safety-related projects—851 of which are under way or completed—at a cost of 1.2 billion ECU ($1.59 billion). The G-24 Nuclear Safety Assistance Coordinating Center uses this information to identify duplication, overlap and gaps in ongoing and planned projects. The IAEA has reviewed and critiqued the database, and is adding its own database on safety issues to that for donor projects.

Establishment of the Nuclear Safety Account

Although many bilateral assistance programs were under way in the early 1990s, some of the G-7 nations—notably Germany and France—wanted to create a multilateral fund to get help flowing for short-term improvements at older RBMKs and VVER-440 Model V230s, which was not being done through bilateral efforts. When the G-7 leaders met in Munich in July 1992, they agreed to create such a fund.

The Nuclear Safety Account (NSA) was established in February 1993 by the donors—the countries of the G-7, plus the European Union. The NSA is open to all countries. In addition to the donors, those having pledged or made contributions include Denmark, Finland, the Netherlands, Norway, Sweden and Switzerland.

The NSA was created to supplement bilateral aid efforts, in particular those activities that individual countries are unable or unwilling to undertake. The fund is being used for improvements in both operational safety (development of accident procedures, organizing operations hierarchy) and safety-related hardware (safety systems monitoring equipment, leak detection devices, fire detection, emergency diesels).

The European Bank for Reconstruction and Development (EBRD) staffs and administers the NSA. A steering group of representatives from donor countries—the Assembly of Donors—identifies prospective recipient countries. The EBRD suggests country-specific projects and the Assembly of Donors has final approval of the projects.

In April 1996, the bank's president, Jacques de Larosiere, said that the basic purpose of the NSA was to finance short-term upgrades with a view to increasing the safety of existing nuclear reactors. However, bank officials made clear in March 1997 that NSA donors want the fund to focus on shutdown of unsafe plants.

NSA Projects. The first project approved was a 24 million ECU ($25.4 million) grant to Bulgaria for upgrading safety at the Kozloduy plant's units 1-4.

A second grant—33 million ECU ($34.9 million)—was awarded to Lithuania to purchase equipment for short-term safety upgrades at the Ignalina plant. A portion of the grant is being used for a safety assessment, which was completed in early 1997. The Lithuanian regulatory body will use the assessment to help make a decision on the plant's continued operation.

The next two projects are in Russia, one at the Leningrad plant and the second, a joint project between the Novovoronezh and Kola plants. The Leningrad plant—which has the status of a separate operating utility—will receive 30.62 million ECU ($32.4 million), and Rosenergoatom—the operating utility for the Novovoronezh and Kola plants—will receive 44.9 million ECU ($47.5 million). In addition, Gosatomnadzor—the regulatory authority—will receive 0.9 million ECU ($900,000) to use in setting up a full licensing system for Russia's least-safe reactors, the RBMKs and VVER-440 Model V230s. The grant agreement stipulates that this system be used to evaluate whether the plants should be shut down or permitted to operate for a limited time.

In September 1996, the EBRD's Nuclear Safety Account sought bids for a Project Management Unit that would guide the work needed to close Chernobyl. Two months later, the bank offered a 118 million ECU ($125 million) grant for the Chernobyl project. It included 85.8 million ECU ($90.9 million) for the provision of an interim spent fuel facility and a liquid radwaste treatment facility, 13.5 million ECU ($14.3 million) for short-term operational safety improvements at Unit 3, and about 9 million ECU ($9.5 million) for the PMU.

All grant agreements include conditions that are designed to lead to the phased shutdown of the units receiving short-term upgrades. In addition, all agreements require that recipients develop an acceptable energy-sector plan that takes into account nuclear safety.

G-7, EU Chernobyl Package

In June 1994, the European Union pledged 100 million ECU ($106 million) in grants over three years to help Ukraine develop energy-sector programs that would enable it to close the Chernobyl nuclear power plant as early as possible. The EU also offered 400 million ECU ($424 million) in Euratom loans for the reactors' completion.

The following month, the G-7 agreed to provide a grant of up to $200 million in support of an action plan for Ukraine's energy sector that could lead to the early decommissioning of the Chernobyl plant. At their meeting, the G-7 leaders called on other donors and international financial institutions to provide support for the action plan.

During talks in the fall of 1994, Ukrainian officials reportedly told the G-7 that the country agreed in principle to close Chernobyl. In December, a joint task force was created—representing the G-7 and the Ukrainian government—to flesh out the action plan by deciding on specific actions, who would take them, how much they would cost and the time they would take.

In April 1995, President Kuchma said that Ukraine would develop a timetable for closing Chernobyl by 2000. To effect closure, the government said $4 billion in Western aid was needed for decommissioning, fixing the sarcophagus surrounding the damaged Unit 4, developing alternative energy sources, and defraying the social costs of closing the plant. At their June meeting, the G-7 leaders congratulated President Kuchma on his commitment to shut down Chernobyl by 2000, and offered to mobilize an additional $2 billion for energy assistance to Ukraine.

By the end of October, the two sides were working on a plan to provide $1.8 billion in credits and $500 million in grants to restructure Ukraine's electric power sector and shut down Chernobyl. In addition, the G-7 wanted Ukraine to contribute $900 million, according to a Ukrainian news service. In late November, Ukrainian and G-7 negotiators agreed on a draft memorandum of understanding on Western support for such a comprehensive plan.

Ukraine and the G-7 signed the memorandum in December 1995 in Canada, which served as chairman of the G-7 in 1995. Under the agreement, the G-7 will provide $498 million in grants already committed, and $1.809 billion in international and Euratom loans.

At the April 1996 Moscow nuclear safety summit meeting of the leaders of the G-7 and Russia, President Kuchma reiterated Ukraine's commitment to close Chernobyl by 2000, and said that the plant's Unit 1 would be shut down before the end of the year. Unit 1 was closed Nov. 30.

At a February 1997 meeting, Ukrainian and G-7 officials agreed on a plan for the Chernobyl sarcophagus, and in April, the two sides reached specific agreement on implementing the MOU. Under the agreement, Ukraine is to receive $900 million in loans and grants by mid-1997. Most of the money will be spent on developing the country's energy market, restructuring its coal industry and modernizing its hydroelectric plants. A $120 million grant will be used for work at the Chernobyl plant.

At the June 1997 summit meeting of G-7 leaders and Russian President Boris Yeltsin, the G-7 noted that it had made "significant progress" in implementing the MOU. The leaders reaffirmed their commitment to help Ukraine in "mobilizing funds for energy projects to help meet its power needs in 2000 and beyond after Chernobyl's closure." They said that to date, projects totaling more than $1 billion had been agreed.

G-24 Assistance: Other Players

WANO. In addition to the OECD's NEA, the CEC and the IAEA, the World Organization of Nuclear Operators (WANO) is involved in the G-24's activities through its special project—initiated by the Moscow and Paris WANO centers—to suggest improvements to reactors in Eastern Europe and the former Soviet Union.

International Lenders. Although the EBRD is administering the Nuclear Safety Account, two other international lending bodies—the World Bank and the European Investment Bank (EIB), which is the financing institution of the European Union—also have roles to play.

The EIB is considering the adoption of policies that would allow it to fund nuclear safety projects in Eastern Europe, including longer-term projects for the VVER-440 model 213 and VVER-1000 reactors. For the longer term projects, the EIB will administer a 1.1 billion ECU ($1.16 billion) loan facility for Euratom. At present, the World Bank's policy is not to fund construction of new nuclear power plants or improvements to operating units. Instead, the bank is helping countries with these reactors to strengthen other aspects of their power sectors to ensure the development of market-oriented power sectors that are capable of supporting such externalities as safety.

In addition to these lending institutions, some of the export/import agencies of the G-24 nations are providing funds to guarantee loans for nuclear safety projects, according to a U.S. government official. It is U.S. policy to guarantee loans for projects involving Soviet reactors of more modern design—the VVER 1000. The U.S. Export-Import Bank, for instance, is guaranteeing a $317 million loan to CEZ, the Czech national utility, for Westinghouse Electric to upgrade and complete two VVER-1000 units at the Temelin nuclear power plant.

Bilateral Assistance

The European Union: Two Major Programs

Under its PHARE and TACIS nuclear safety programs, the European Union seeks to support and accelerate Central and Eastern European efforts aimed at: strengthening nuclear regulatory bodies, implementing operational safety improvements through on-site assistance, conducting design safety studies and providing equipment for nuclear plants.

PHARE Program. The PHARE program, set up in 1989 for aid to Poland and Hungary, was extended in 1990 to Bulgaria, Czechoslovakia, Yugoslavia and Romania.

Under the program, the EU provides—at a country's request—technical assistance, training, feasibility studies, and activities to improve countries' regulatory framework, build institutions and launch small pilot projects. It does not, however, fund major projects, leaving such investment to the private sector and international lending bodies.

In the nuclear energy area, PHARE's objective is to improve operational safety and operator training. PHARE activities in the former Czechoslovakia—now the Czech Republic and the Slovak Republic—include a probabilistic safety assessment for the Bohunice nuclear plant, plus instrumentation and control studies for the VVER-440 Model V213 and the VVER-1000. During 1990-91, 7 million ECU ($7.4 million) was spent.

In Bulgaria, a crash project was launched in 1991 involving a "twinning" program in which the staffs of the Kozloduy plant and Western European nuclear plants exchanged experience; a "housekeeping" program for Kozloduy; and a special WANO-organized, six-month safety analysis.

In Lithuania, a 1.75 million ECU ($1.8 million) general energy project included a safety assessment of the Ignalina nuclear plant.

The 10 operating VVER-440 Model 213 reactors in Eastern Europe—four in the Czech Republic, two in Slovakia and four in Hungary—will receive instrumentation and control upgrades under a PHARE project.

The Cassiopee consortium—created in 1993 to help the countries of Eastern Europe develop radioactive waste management systems—has sent teams to Bulgaria, the Czech Republic, Hungary, Lithuania and the Slovak Republic to learn about the radioactive waste management situation. On the basis of these visits, the consortium was asked to draw up terms of reference for specific projects in these countries.

Expenditures for 1990-91 totaled 20 million ECU ($21.2 million). Under the PHARE program, 28.3 million ECU ($29.9 million) was allocated for operation improvements, safety authorities, safety studies and regional waste policy in 1992. For both 1993 and 1994, 25 million ECU ($26.5 million) was allocated. The EU also allocated 5 million ECU ($5.3 million) of PHARE money in 1994 for the EBRD's Nuclear Safety Account. For 1995, 27 million ECU ($28.6 million) was allocated for safety-related activities. For 1996, PHARE funding was limited to an allocation of 6 million ECU ($6.36 million) for Bulgaria.

TACIS Program. Under a separate program of technical assistance, in 1991 the EC allocated 54 million ECU ($57.2 million) for nuclear safety measures in the CIS (Commonwealth of Independent States) countries. This sum covered operational safety measures, mainly for the VVER-440 Model V230, training and management centers, and support of safety authorities. But with the breakup of that country, funding was delayed while the EC waited for the newly independent republics to decide how to divide up the money originally allocated to the U.S.S.R.

By early 1993, the logjam was finally broken, and the EC began evaluating bids of about 23 million ECU ($24.3 million) for 23 projects involving safety systems upgrade work, waste management, emergency procedures, measurement technology and training at VVER plants in Russia and Ukraine. Total funding for nuclear safety under the 1991 TACIS program was 32 million ECU ($33.9 million). Among the projects was one involving the transfer of Western probabilistic safety assessment and external events methodology and experience to Russia for use in identifying weaknesses, assigning priorities to modifications and verifying the validity of proposed modifications to VVER-440s and VVER-1000s.

For 1992, 80 million ECU ($84.8 million) was allocated for safety-related work under the TACIS program. An additional 20 million ECU ($21.2 million) was earmarked for the International Science and Technology Center. Of the 80 million ECU, 32 million ECU ($33.9 million) is intended for upgrades at six Russian plants—Kola, Kalinin, Beloyarsk, Smolensk, Balakovo and Leningrad (Sosnovyy Bor)—and two Ukrainian plants—Rovno and South Ukraine. The upgrades include: the installation of computerized protection systems; the provision of inspection tools for detecting cracks, welding equipment and spare parts; and the training of operators. To carry out the work, small teams of Western European experts went to the eight plants in the summer of 1993 for assignments of six to 12 months. Another 30 million ECU ($31.8 million) was used for inspections and safety analyses of the plants.

In addition to its work in Eastern Europe under the PHARE program, the Cassiopee consortium is working under the TACIS program in Ukraine, where national radioactive waste strategies are being developed, and in Russia's Kola peninsula, where an integrated management plan for a repository is being developed.

For 1993, the EU allocated 88 million ECU ($93.2 million) for the TACIS program, and for 1994, 91 million ECU ($96.4 million). In addition, 7.5 million ECU ($7.9 million) was allocated in 1994 for the G-7 action plan. The EU also allocated 15 million ECU ($15.9 million) of TACIS money in 1994 for the Nuclear Safety Account. For 1995, 96 million ECU ($101.7 million) has been allocated for the TACIS program. The allocations for 1994 and 1995 included funding for the G-7's action plan for Ukraine. The 1996 allocation was 80 million ECU ($84.8 million), including a 250,000 ECU ($265,000) grant to prepare a Euratom loan project for Kalinin Unit 3 in Russia.

Joint Assistance. With 8 million ECU ($8.4 million) in funding from the EU's PHARE and TACIS programs, a Western European consortium of four companies—Belgatom, Corys, Siemens and Thomson—agreed to deliver multifunctional simulators for training plant operators to six nuclear plants: Kozloduy (Bulgaria), Dukovany (Czech Republic), Bohunice (Slovak Republic), Kola and Novovoronezh (Russia), and Rovno (Ukraine). The project, launched in January 1995, was slated for completion in December 1996.

County-to-Country Aid: Still Growing

In addition to participating in the Nuclear Safety Account, a number of countries have launched their own efforts to improve the safety of Soviet-designed reactors.

United States. In 1991, the U.S. government launched its first assistance program, with $3 million in funding earmarked for the three Eastern European countries with Soviet-designed reactors. In 1992, the United States held the Lisbon Coordinating Conference on Assistance to the Newly Independent States of the Former Soviet Union. One product of the conference was a three-part program covering operational safety improvements, risk reduction and regulatory assistance. The U.S. government allocated $25 million for fiscal year 1992, with about $22 million going to the Department of Energy (DOE) and about $3 million to the Nuclear Regulatory Commission (NRC).

With this funding, DOE has helped to establish two training centers—one for Russia (at the Balakovo plant) and one for Ukraine (at the Khmelnitskiy plant)—to improve operational safety. The centers, which will be equipped with VVER-1000 simulators, will be used to train technical and maintenance staff as well as operators. The U.S. government is providing the simulator for Khmelnitskiy.

Under this part of the program, DOE is also helping Russia, Ukraine and the Eastern European countries to develop emergency operating procedures as well as normal written operating procedures for three major reactor types. Joint expert working groups—including Russians, Ukrainians, Americans and East Europeans—have been writing procedures for the VVER-440 Model V213, the VVER-1000 and the RBMK. Emergency operating procedures for the VVER-440 Model V230 were written by Working Group 11 of the Joint Coordinating Committee on Civilian Nuclear Reactor Safety as part of the U.S. government's ongoing cooperation begun in 1988 with the Soviet Union.

For risk reduction, the initial effort focused on fire detection, prevention and suppression. DOE contractors have helped design, build and install fire protection equipment in Bulgaria, Russia and Ukraine. The equipment is selected on the basis of a study of fire hazards and a walkdown at each plant. Other work involves provision of emergency diesel generators and leak-tight sealant. For details, see **DOE Programs**.

The NRC is responsible for the regulatory assistance part of the program, which involves helping these countries to develop a regulatory management structure and establish a national basis for licensing and inspecting plants. Since 1992, Russian and Ukrainian regulators have visited the NRC each year to develop a list of activities they want to carry out under the program. For details, see **NRC Programs**.

For fiscal year 1993, the U.S. government provided $15 million for nuclear safety assistance activities in Ukraine, and $15 million for Russia. For fiscal year 1994, the government provided about $33 million in assistance for Ukraine and about $75 million for Russia. For fiscal year 1995, the government provided $9 million for Ukraine and $8.5 million for Russia.

Ukraine received $23.4 million and $42.5 million for fiscal years 1996 and 1997, respectively, and Russia received $26.1 million and $26.2 million for fiscal years 1996 and 1997, respectively.

In addition, the government has earmarked $27 million to finance decontamination and decommissioning work and to stabilize the Chernobyl sarcophagus.

The government also has a reactor safety assistance program targeted at Eastern Europe, but on a much more modest scale. Program funding for fiscal year 1992 was $4.5 million; for fiscal year 1993, it was about $3 million; for fiscal year 1994, $3.6 million; and for fiscal year 1995, $3 million. The Eastern European program received $2.46 million for fiscal year 1996, and $7.66 million for fiscal year 1997.

Japan. Japan's Ministry of International Trade and Industry (MITI)—together with the country's Science and Technology Agency—has launched a program involving short- and long-term technical assistance and a major operator training effort.

Under the training program, groups of operators, managers, maintenance personnel and inspectors from Russia, Ukraine, Bulgaria, Hungary, the Czech Republic and the Slovak Republic have taken part in various two-week training courses in Japan. Over the course of 10 years, MITI plans to train 1,000 people.

As part of its short-term assistance, Japan plans to install a sophisticated early-warning system to detect coolant leakage in RBMKs and VVER-440 Model V230s. The country's long-term aid will entail the construction of an operator training center, with a simulator, at the Novovoronezh nuclear power plant in Russia. It will also include tests of VVER thermohydraulic safety.

Under an agreement signed by MITI and the Russian Ministry of Atomic Energy in mid-1993, Japan has given Russia a $25 million full-scope training simulator for use at the Novovoronezh plant, which has three VVER units. Novovoronezh is the training center for Russian VVER operators.

In fiscal year 1993, Japan earmarked 1.95 billion yen ($16.4 million) for seven categories of bilateral safety-related assistance to nuclear programs in the former Soviet Union and Eastern Europe.

Germany. The German government first provided nuclear safety assistance for Soviet-designed reactors in 1991, when it gave Bulgaria's Kozloduy plant about DM 19.5 million ($10.4 million) worth of spare parts from the Greifswald nuclear plant in eastern Germany. Germany earmarked DM 33 million ($17.6 million) for bilateral nuclear safety assistance to the former Soviet Union in 1993 and plans to provide an additional DM 21 million ($11.2 million) in technical assistance to two VVER-1000 plants in Russia and Ukraine. In a joint venture with France, Germany will spend about $1.2 million to provide Russian nuclear regulators with a data communications network and other equipment, and about $450,000 to provide the same equipment to Ukrainian regulators.

In 1992, German nuclear plant owner-operators launched a twinning program with VVER plants in the East. The program involves the exchange of information and temporary assignment of personnel.

Through 1995, Germany will have contributed or allocated a total of DM 203.5 million ($109 million) for bilateral projects and DM 64 million ($34.3 million) for the Nuclear Safety Account.

France. France's utility, Electricité de France, and Russia's Ministry of Atomic Energy signed an agreement in 1992 pledging closer cooperation between nuclear plant operators in their two countries. The agreement also called for the creation of a joint venture in engineering for nuclear plant operations.

EdF is also working with Russia's Rosenergoatom to develop accident procedures for the VVER-1000 and is discussing with that organization the transfer of a machine developed in France to repair vessel closure head flanges and the joint development of a mockup plant to train Russian technicians in maintenance techniques. In addition, Russian design institutes are said to be adopting EdF's double-walled containment design for a new generation of VVER-1000s, and EdF is helping the Russians with quality assurance and control for nuclear construction.

In mid-1993, EdF and a group of Russian institutes and companies agreed to develop an upgrade program for the VVER-1000. The program, issued in mid-1995, provides a methodology for selecting, classifying and prioritizing all the modifications considered necessary or desirable for safety, availability and operability of the VVER-1000.

By mid-1994, France had contributed a total of 230 million ECU ($243.8 million) for bilateral and multilateral projects: 65 million ECU ($68.9 million) for the PHARE and TACIS programs; 30 million ECU ($31.8 million) for the Nuclear Safety Account; and 135 million ECU ($143.1 million) for bilateral cooperation.

In early 1996, the French government was reportedly seeking ways to promote partnership relations between the French and Russian nuclear industries, including cooperation with the Russian design and engineering institutes responsible for the original reactor designs.

Canada. In 1992, Canada pledged Canadian $30 million (U.S. $21.9 million) to a nuclear safety initiative. The initiative includes a Canadian $11 million ($7.9 million) nuclear safety engineering program, Canadian $750,000 ($543,000) for participation in the RBMK consortium, Canadian $210,000 (U.S. $152,040) for a peer review project at Lithuania's Ignalina's plant, and Canadian $600,000 (U.S. $434,400) for the first phase of an internship and training program for regulatory staff from Lithuania, Ukraine and Russia. In May 1993, Canada contributed Canadian $7.5 million (U.S. $5.4 million) to the Nuclear Safety Account.

Sweden. Sweden provided Kr 70 million ($8.7 million) in bilateral aid to Lithuania during the 1991-93 period. Some of the funding has gone to the "Barselina" project, a cooperative effort among Sweden, Lithuania and Russia (see below). Although the project was concluded in 1996, it will continue under the name Barselina 2000 as a cooperative Lithuanian-Swedish effort aimed at improving safety management and plant performance at Ignalina. In addition, Swedish funding has been used to aid Lithuania's regulatory agency and for upgrades at Ignalina, in particular fire safety improvements.

Sweden also has contributed $3 million to the Nuclear Safety Account and has said it will contribute an additional $3 million. Sweden's Environment and Natural Resources Department requested Kr 56 million ($6.9 million) for fiscal year 1994-95 for nuclear safety and radiation programs in the Baltic countries.

Finland. The Finnish government has provided FM 14.4 million ($2.5 million) to fund two projects in Russia, one at the Kola plant and one at the Leningrad plant.

Nuclear Liability: The Search for Solutions

Russia, Ukraine, Lithuania and the four Eastern European countries with Soviet-designed nuclear plants—the Czech Republic, the Slovak Republic, Hungary and Bulgaria—are signatories to the Vienna Convention, which ensures that the responsibility for damage caused by a nuclear accident is channeled to the plant operator.

Both Russia and Ukraine have signed the Vienna Convention. In 1995, the Ukrainian parliament passed nuclear legislation that included a provision channeling legal responsibility for a nuclear accident to the operating organization. Although the measure was signed into law by President Kuchma, implementation must await the passage of a by-law by parliament. As a temporary measure, parliament gave the Ukrainian government the right to exempt foreign entities from responsibility for third-party nuclear damage. Also in 1995, both the upper and lower houses of Russia's parliament approved nuclear energy legislation that included a provision on nuclear liability. President Yeltsin signed the law in November 1995. The type and limits of liability of the operating organization will be spelled out in separate legislation.

Lithuania passed a nuclear law in 1993 consisting essentially of the Vienna Convention's liability provisions. Its nuclear legislation, which includes a more comprehensive set of regulations, was approved by parliament in late 1996.

The four Eastern European countries with Soviet-designed nuclear plants—the Czech Republic, Slovak Republic, Hungary and Bulgaria—have enacted nuclear legislation that includes liability provisions. In addition, the Czech Republic established a nuclear insurance pool in July 1995, and the Slovak Republic and Bulgaria are taking steps to set up such pools.

The government-to-government agreements on liability protection signed by Russia and Ukraine with the United States in 1993 satisfied several U.S. companies, and the U.S. assistance program is operational. A memorandum of understanding signed by the European Commission and Russia in

February 1995—under which Russia offers liability protection to companies doing safety-related work under the EU's TACIS program—is considered adequate by many of those companies. The EC is reportedly engaged in discussions with Ukraine on a similar agreement. Russia also issued an indemnity statement in June 1995 that offered liability protection to all contractors doing safety-related work under the EBRD's Nuclear Safety Account grant.

Separately, Germany's Siemens arranged indemnities for all third-party liability with the Eastern European countries in which it is carrying out safety-related upgrades.

Most Western contractors and suppliers remain unwilling to install safety-related equipment that directly affects Russian and Ukrainian plants' reactor operation because of the lack of full legal and financial protection in the event of an accident.

IAEA Standing Committee. Between 1990 and 1994, the IAEA Standing Committee on Nuclear Liability held more than a dozen meetings in an attempt to reach agreement on amendments to the Vienna Convention that would improve its coverage and attract more signatories worldwide. In 1994, the U.S. government proposed a supplemental funding scheme—an "umbrella" convention—to break the committee's stalemate. The Convention on Supplementary Funding, together with a protocol to amend the 1963 Vienna Convention, revise the international regime for nuclear liability. The two instruments are expected to be finalized at the Diplomatic Conference on Liability for Nuclear Damage tentatively scheduled for September 1997 in Vienna.

Barselina Project

The Barselina project was a cooperative effort among Sweden, Lithuania and Russia to transfer the methodology for probabilistic safety analysis (PSA) from Sweden's Barsebäck plant to Lithuania's Ignalina plant. The aim of the project, run by SKI, the Swedish Nuclear Power Inspectorate, was to assess the risks of accidents occurring at RBMKs and use the results to identify areas for improvement in system design and operating and maintenance procedures.

The project consisted of three phases: familiarization with safety systems, limited level 1 PSA, and full level 1 PSA. During phase 2, a qualitative PSA model of Ignalina Unit 2 was developed for testing and demonstration. Phase 3 was completed in mid-1994, and the results of the PSA identified a number of improvements in RBMK system design as well as operating and maintenance practices, some of which had been implemented by Ignalina or were under way.

Among the suggested improvements: increase the capacity of the reactor cavity relief system, provide redundancy and diversity of fresh water supply, improve reliability of main steam relief valves, improve battery capacity, diversify emergency power sources and improve operating procedures.

The project revealed the plant's weaknesses, but it also showed that the plant has advantages and good design features. If all the changes proposed by the project were made, the probability of a severe accident at Ignalina 2 could be reduced from one in 10,000 to one in 100,000 reactor years. The U.S. Department of Energy is carrying out a peer review of the results of the project.

During the fourth phase—which ran from July 1994 to September 1996, the Ignalina PSA was refined, taking into account plant changes, improved modeling methods and greater plant information on events and dynamic effects. The project will continue under the name Barselina 2000 as a cooperative Lithuanian-Swedish effort aimed at improving safety management and plant performance at Ignalina.

Based on the work done for the Barselina project, Western experts talked with officials from Russia's Research and Development Institute of Power Engineering (RDIPE)—the design institute for RBMKs—and the Leningrad plant about carrying out a similar probabilistic safety analysis at the Russian plant. Work began on the project in September 1996 after more than two years of negotiations between representatives of the U.K.'s AEA Technology, the U.S. Department of Energy and the Swedish International Project and plant management and RDIPE. Data collection for a level 1 PSA began in March 1997, and the project is expected to be completed in September 1998.

RBMK Review

In addition to the IAEA's RBMK study, discussed in the **IAEA Programs** section, the European Communities (now the European Union) commissioned an RBMK safety review. The purpose of the review was to develop a better understanding of the RBMK design and operation, which would enable Western experts to provide advice on safety improvements that might be funded by the West.

The review brought together four EU countries—the United Kingdom, France, Germany and Italy—and three other countries with ongoing bilateral projects in the former Soviet Union—Canada, Sweden and Finland—into a seven-nation Western consortium.

Working with this consortium is an Eastern counterpart—a group of former Soviet design and research institutes, plant operators and regulators. The activity of the two consortia—broken into nine technical task groups—is guided by a steering committee under joint British-Russian chairmanship. The task groups covered: system engineering and accident progression, protection systems, core physics, external events, engineering quality, operating experience and analysis, human factors, regulatory aspects, and probabilistic safety assessments.

Although the project was announced in October 1991, EU funding delays and problems in arranging terms with the former Soviet participants held up the launch of the review until early 1993. In March, the two consortia agreed to proceed with the one-year review, which was to incorporate EU-funded work at Russia's Smolensk 3, the newest generation of RBMK, work that Sweden has done at the Ignalina RBMK plant in Lithuania, and work that Finland has done at the Leningrad (Sosnovyy Bor) RBMK plant in Russia.

The EU agreed to provide 4.4 million ECU ($4.6 million) to cover the contributions of the four EU countries plus coordination of the review, and the three other countries contributed a similar amount.

The project, which was completed in late spring 1994, produced more than 300 recommendations—hardware changes as well as management and operational reforms—for improving RBMKs. Improvements to safety culture and management practices were considered a top priority for the improvement of safety, and the project members concluded that implementing these improvements would be highly cost-effective.

Other Assistance

International Science and Technology Center. Officials from the United States, the Russian Federation, Japan and the European Union have established the International Science and Technology Center (ISTC) in Russia to retrain ex-Soviet weapons scientists for new jobs outside the weapons field. Biological, chemical, nuclear and missile weapons scientists are working with U.S. companies, universities and government organizations through projects approved the ISTC board of directors. Several nuclear safety projects are under way through the center.

The center is headquartered in Moscow, with branch offices in Kazakhstan and Belarus. Initial funding came from the United States ($25 million), the EU ($25.2 million) and Japan ($20 million). Russia provides facilities for the center, as well as maintenance, utilities, security and related support.

In addition, the United States, Sweden and Canada have established a sister facility in Ukraine—the Science and Technology Center of Ukraine—for similar purposes.

Joint Core-Melt Experiments. The Organization for Economic Cooperation and Development's Nuclear Energy Agency is collaborating with Russia's Kurchatov Institute in experiments of the physical-chemical interactions between a molten core and reactor vessel steel. The results could be used in advanced reactor design as well as for mitigating the consequences of core-melt accidents at operating reactors.

This project, which was the object of bilateral cooperation between the U.S. Nuclear Regulatory Commission and the Kurchatov Institute, was taken over by NEA's Committee on the Safety of Nuclear Installations.

The Kurchatov Institute is building a facility for the experiments, which are expected to cost about $5.5 million and run for three or four years. The Russians, who want to apply the results of the experiments to both current and planned VVER-1000 reactors, are apparently willing to pay for about 40 percent of the project's cost.

The project began in 1994, with a three-year budget of $6.9 million. The participating countries are: Belgium, Canada, Finland, France, Germany, Italy, Japan, the Netherlands, South Korea, Spain, Sweden, Switzerland, the United Kingdom and the United States. In October 1996, the first major simulation of a core melt took place at the Kurchatov Institute. The project will end in 1997.

Fuel Cycle Consortium. In July 1993, five nuclear fuel cycle companies from the European Union formed the European Fuel Cycle Consortium to support EU programs aimed at enhancing the safety of Soviet-designed reactors.

Safety Organization Group. In August 1993, the heads of nuclear safety organizations in France, Germany, the United Kingdom, Belgium, Spain and Italy agreed to set up the Technical Safety Organization Group. A major aim of the group is to help coordinate the EU's assistance projects under its PHARE and TACIS programs.

IEC RBMK Study. In January 1992, a working group of the International Electrotechnical Commission (IEC) proposed to undertake work aimed at improving RBMK instrumentation and control (I&C) systems. The IEC approved the proposal and began work in 1993, requesting support from the International Atomic Energy Agency (IAEA). The IAEA provided financial and technical support, including Russian experts in RBMK I&C systems. The IEC and Russian project participants identified RBMK I&C safety issues and made eight main recommendations for such systems as data processing, the shutdown system, fuel cooling, power distribution, leak detection and hydrogen monitoring.

NUCLEAR SAFETY ASSISTANCE: THE NRC'S ROLE

In 1988, the U.S. Nuclear Regulatory Commission (NRC) began exchanging information with Soviet nuclear experts with the aim of improving nuclear plant safety. Since the breakup of the Soviet Union, much of this activity has taken the form of nuclear regulatory assistance to Russia and Ukraine as well as the Czech and Slovak republics, Hungary, Bulgaria and Lithuania.

FORMER SOVIET UNION

Laying the Groundwork. U.S. representatives and officials of the former Soviet Union began exchanging information informally in the wake of the Chernobyl accident, with investigation into the causes and consequences of the event. In April 1988, they set up an official framework for information exchange by establishing the Joint Coordinating Committee on Civilian Nuclear Reactor Safety (JCCCNRS). The JCCCNRS agreement resulted in the formation of 10, later 12, working groups that would address a range of issues involved in nuclear plant operations and design.

Restructuring Under the Lisbon Initiative. With the announcement of the Lisbon Initiative in 1992 by then-U.S. Secretary of State James Baker, emphasis on nuclear safety cooperation with the U.S.S.R. shifted to nuclear safety assistance for Russia and Ukraine

As a result, Russian, Ukrainian and NRC representatives developed priorities that concentrated on building a regulatory program for each new nation. Each country needed, for example, licensing programs, trained inspectors, inspection methods and an emergency response center. In short, they needed all the programs necessary to regulate and inspect their nuclear plants. In addition, both Ukraine and Russia needed legislation to endow their regulatory agencies with the proper authority. Working with NRC representatives in July 1992, Russian authorities established seven (now 10) regulatory priorities, and Ukrainian authorities established 16 (now 17).

The U.S. Agency for International Development (AID) began to fund the effort through annual agreements signed with the NRC beginning in

September 1992. Cumulative funding of approximately $9 million has been provided to support regulatory assistance for Russia and Ukraine. This money does not include funds received by the U.S. Department of Energy (DOE) to improve the safety of plant operations. The U.S. nuclear safety assistance program was to be administered through the JCCCNRS. Its leadership was expanded to include DOE and the Russian Ministry of Atomic Energy because of their substantial involvement.

Of the 12 JCCCNRS working groups, four are still in operation in one form or another, four have completed their work and four have been subsumed by the Lisbon Initiative.

Transformation of Working Groups

The assistance program led to substantial changes in the cooperative programs with Russia and Ukraine. Only two JCCCNRS working groups continue their operations as in the past—Working Groups 3 and 12. Two others were transformed: Working Group 6 on severe accidents came under a cooperative research agreement between the NRC and two Russian research institutes, and Working Group 7 on health effects came under agreements between the United States and Russia, Belarus and Ukraine.

Working Group 3: Irradiation Embrittlement and Reactor-Vessel Annealing

Both U.S. and ex-Soviet members of this working group have shared lessons learned about the effects of neutron irradiation on the embrittlement of reactor pressure vessel materials, about the methods used in each country for evaluating the structural integrity of pressure vessels, and about the ability of thermal annealing to restore the ductility of pressure vessel materials to near their as-fabricated state.

During 1996, both the U.S. and the Russian sides carried out mechanical property tests on specimens of selected materials from VVER-1000 pressure vessels. U.S. interest derives from the possibility that some pressure vessels in the United States will be annealed.

Data from VVER-1000 reactor types was evaluated and a benchmark was established for reactor vessel dosimetry for VVER-440 plants. Participants in the work also reported on the irradiation and annealing of steels from U.S. reactors and Russian VVER-1000 reactors.

At the 1996 meeting, the two sides agreed to recommend that Working Group 3 and Working Group 12, on nuclear power plant aging and life extension, be combined.

Working Group 6: Severe Accidents

Working Group 6 has come under a cooperative research agreement between the NRC and two Russian agencies—the Russian Research Center at Kurchatov and the Russian Academy of Sciences' Institute of Nuclear Safety. Current work by Kurchatov consists of: model development and calculations on hydrogen combustion, evaluation of high burnup fuel test data, and investigation of mechanisms for in-vessel cooling of molten core debris. Current work by the Institute of Nuclear Safety consists of: development of models for NRC severe accident codes, development of failure data for concrete containments of nuclear power plants, investigation of uncertainties for probabilistic risk analysis techniques, and enhancement of NRC thermal-hydraulic codes.

Working Group 7: Health Effects and Environmental Protection Considerations

Working Group 7 began with an agreement between the United States and the Soviet Union to form two subgroups to study the effects of the Chernobyl accident. One subgroup addressed health effects, and one focused on environmental effects.

After the breakup of the Soviet Union, separate projects were planned with Russia, Ukraine and Belarus. In 1993, research focused on human health, restricting environmental research to that necessary for health studies. The U.S. effort involved several federal agencies, a national laboratory and several universities.

Under a separate agreement with Russia, the scope was extended beyond Chernobyl to include radiological health effects in other regions of Russia. A Joint Coordinating Committee for Radiation Effects Research (JCCRER) was established in 1994 to direct the joint research, which is currently concentrating on radiation health effects in the southern Urals. Three research directions were approved at the 1994 meeting:

- medical aspects of radiation exposure of the affected population
- medical aspects of exposure of personnel and
- information technologies in research on radiation effects and decision-making support.

JCCRER meetings were also held in October 1996 and April 1997.

Five feasibility studies have been completed, and full-scale studies have begun or will do so shortly. The NRC is considering the management and funding of one of these studies.

Epidemiological studies related to the health effects of radiation-induced thyroid disease in children in the exposed population and personnel in Belarus and Ukraine have begun. In Ukraine, studies of the occurrence of leukemia and cataracts among Chernobyl cleanup workers are also being conducted.

In the Belarus study, which involves about 15,000 children, the project infrastructure has been developed and a scientific protocol has been completed. The project was officially initiated in December 1996, and initial screening of exposed individuals has begun.

In Ukraine, progress includes:

- completion of a scientific protocol for a thyroid study of 50,000 children and completion of a pilot test for screening affected individuals

- completion of a scientific protocol for a study of leukemia in Chernobyl cleanup workers, with necessary approvals obtained
- continuation of a study of the incidence of radiation-induced cataracts among Chernobyl cleanup workers (a DOE-funded study).

More than 50 scientists have been involved in the projects in Belarus, Ukraine and Russia.

Working Group 12: Nuclear Power Plant Aging and Life Extension

When Working Group 12 met in 1996, several tasks had been completed—the selection of equipment vulnerable to aging, the identification of mechanisms that degrade equipment, managing the aging process,; and understanding the mechanics of the ways in which piping fractures.

The combination of Working Groups 3 and 12 was recommended. The combined working group will pursue cooperative research on the effects of reactor operations on the aging and overall reliability of critical nuclear reactor systems, structures and components.

Status of Other Working Groups

Of the other eight working groups, four have completed their activities (Working Groups 2, 4, 5 and 10). These dealt with nuclear power safety design, fire safety, backfitting and modernization, and the effects of corrosion on piping. Four groups (Working Groups 1, 8, 9 and 11) have been subsumed by the new Russian and Ukrainian regulatory priorities under the Lisbon Initiative. These dealt with safety approaches and regulatory practices, exchange of operating experience to identify safety issues, plant diagnostics to support operations, and procedures for improving operational safety.

Lisbon Initiative Regulatory Priorities for Russia/Ukraine

The major focus of the joint regulatory priorities has been the transfer of approaches to and methods of safety regulation used by the NRC and the provision of related computer and communications equipment. The aim is to provide assistance that offers self-sustaining benefits.

Russia

Russian Priority 1: On-the-job training for Russian regulators

The NRC is familiarizing the Russian regulatory agency, GAN, with NRC's process for licensing nuclear power reactors. It is doing this through training in all aspects of the process, including safety reviews, licensing procedures, licensing information management, license renewal and related economic issues.

Over the past year, several training trips have taken place on reactor startup procedures, the development of new requirements, and licensing reviews of older plants. GAN has used this information to improve inspection approaches and develop a licensing procedure document.

Russian Priority 1.1: Legislative basis for nuclear regulation and legal enforcement

Legal assistance provided under this priority enabled GAN to develop draft input for Russia's nuclear law. The law, adopted in 1995, provides the legal basis for regulation of nuclear activities in Russia. The NRC has also commented on a draft federal law on the regulation of nuclear and radiation safety, and will offer comments on future nuclear safety legislation as requested.

The NRC has also made recommendations on creating a Russian system of enforcement with economic sanctions, and on implementing a policy of obligations for organizations that operate nuclear power plants.

Russian Priority 2: Training Russian regulators on the principles of the inspection process

The NRC provides on-the-job training and technical assistance on its inspection program. The training and help cover all areas of the inspection process, including planning, resource allocation and implementation.

GAN has modernized selected inspection procedures on systems testing, operational safety and maintenance. The regions have developed 43 inspection procedures.

Russian Priority 3: Creation of Russian emergency support center

The NRC is providing a response plan, with analytical tools, supporting facilities and equipment, and training necessary to improve Russia's ability to respond to emergencies at nuclear power plants. Emergency communications have been installed. In addition, GAN has planned and carried out an emergency response drill. Considerable progress has been made in coordinating the roles of the various Russian response organizations.

Russian Priority 4: Applying U.S. analytical methodologies to Russian safety analyses

The NRC has been helping GAN to establish the capability to perform accident analyses using NRC-developed codes. The effort has included: providing training and technical assistance in analysis methods, providing computer codes and related documentation, and delivering specialized computer equipment. About two years ago, these activities were refocused to support activities under Priority 8: PRA study for the Kalinin VVER-1000 nuclear power plant. Over the last year, the NRC provided codes to GAN so it could develop input decks and analytical models for Kalinin Unit 1.

Russian Priority 5: Building a Russian regulatory training program

The NRC is helping GAN to establish a comprehensive system for training and qualifying GAN technical personnel and for installing a training center for GAN personnel. This effort involves establishing a training curriculum and supplying supporting equipment.

The delivery of office and training equipment was completed over the past year. GAN personnel have developed several training courses for GAN staff, and they are helping to train Russian regulators on RBMK, VVER-440 and VVER-1000 designs.

In addition, plans have been made for the Russians to acquire an analytical simulator—an automated system for simulating a VVER-1000—to train regulatory personnel. While the simulator is being procured and designed, GAN personnel are receiving training in simulator design and operation.

Russian Priority 6: Developing a control and accounting system for nuclear materials

This priority focuses on the development of regulatory approaches to assure control of and accounting for nuclear materials that could be diverted for unauthorized purposes. It complements programs being carried out by other federal agencies under the Comprehensive Threat Reduction Program.

Assisted by NRC training, GAN has carried out inspections at appropriate facilities and defined an information system needed to manage the program. In addition, analytical equipment has been procured.

Russian Priority 7: The inspection of fire protection systems

The NRC has helped GAN in developing methodologies for Russian power reactor protection and post-fire safe shutdown licensing. The agency has provided Russian regulators with a comprehensive technical document outlining the U.S. approach to fire protection. Russian regulators visited the United States for a training course on NRC licensing requirements for fire protection that included classroom instruction and visits to U.S. nuclear plants and laboratories. GAN is currently working with the Ministry of Atomic Energy to reach agreement on approaches to fire safety.

Russian Priority 8: Probabilistic risk assessment study for the Kalinin VVER-1000 Power Plant

The NRC is working with GAN to support GAN's development of a probabilistic risk assessment (PRA) of Unit 1 at the Kalinin VVER-1000 nuclear power plant. The project, in which six Russian organizations are participating, seeks to advance the use of the PRA approach in GAN's regulation of Russian nuclear power plants and to demonstrate the utility of the PRA process.

Specific plans for conducting the PRA have been developed and are being followed. All procedure guides for conducting the analysis have been prepared by NRC and its contractor. In addition, training courses on PRA fundamental applications and related analytical codes have been completed, and a Level 1 PRA has been initiated.

Russian Priority 9: Licensing and inspection of radioactive materials

The NRC is providing GAN with training and experience in the licensing and inspection of the non-military use and disposal of radioactive materials. This effort includes the management and transportation of radioactive wastes and spent fuel as well as radioactive sources used in industry and medicine.

GAN has used the information and training provided by the NRC to develop Russian regulatory documents. Recent documents issued apply to wastes and spent fuel, and conditions for licensing fuel cycle facilities.

Russian Priority 10: Institutional strengthening

The NRC is providing computerized office systems to improve GAN's ability to function effectively as an organization. These systems will enable GAN to establish document control, communicate electronically, and publish safety information. All the equipment to be provided has been identified and procured, and delivery and installation should be completed soon.

Ukraine

Ukrainian Priority 1: General program for developing Ukraine's regulator

The NRC is providing information to Ukraine's Nuclear Regulatory Administration (NRA), and discussing regulatory matters not covered by the specific priorities described below.

Ukrainian Priority 2: Establishing a regulatory training program

The NRC is helping to establish a comprehensive system for the training and qualification of Ukrainian regulatory personnel. These activities include: developing the ability to provide training in several scientific and engineering specialties, and delivering specialized equipment to help in implementing a regulatory training program.

The NRC has delivered and installed advanced video systems and general office and training equipment. The Ukrainians have prepared several training manuals with NRC assistance.

The NRC is also supplying an analytical simulator to the NRA. While the simulator is being developed, the NRC is providing training to appropriate NRA staff on the regulatory uses, as well as the operation and maintenance, of reactor simulators.

Ukrainian Priority 3.1: Developing a system for safety analysis and licensing of nuclear power plants

The NRC is providing on-the-job training and technical assistance on the licensing process for nuclear power plants, with emphasis on safety analysis. Of particular importance are the areas of technical review.

Recent training has been provided in containment construction and operational safety, radiation protection, and the application of new standards to existing plants.

Ukrainian Priority 3.2: Providing analytical support

The NRC is helping the NRA to develop the ability to perform safety analysis using NRC-developed computer codes. As a result of the NRC help, the NRA has adapted the computer codes for the reactors at the Rovno, South Ukraine and Zaporozhye nuclear power plants. In addition, the NRC has provided computer equipment to the NRA.

Ukrainian Priority 4: Joint NRC/Ukrainian inspection project

Through joint inspections at Ukrainian nuclear power plants, the NRC seeks to identify inspection techniques and procedures that the NRA may adopt to enhance team and individual inspector effectiveness. The NRC participated in a joint team inspection to assess the effectiveness of inspection practices at the Khmelnitskiy nuclear power plant. The findings served as a baseline for creating the inspection procedures developed under Priority 5.

Ukrainian Priority 5: Developing Ukrainian inspection activities

Ukrainian regulators have visited U.S. reactor sites to observe the application of NRC inspection procedures and planning processes, and NRC inspectors have visited Ukraine to help in developing regional inspection programs.

With this experience and the results of the joint evaluation of the Khmelnitskiy plant (Priority 4), the NRC is helping Ukrainian regulators to develop a process for assessing plant performance and associated inspection procedures.

Ukrainian Priority 6: Establishing regulatory enforcement

Ukrainian and NRC officials have been meeting since 1992 on the issue of establishing a legal framework that would enable Ukraine's regulatory agency to exercise enforcement and impose penalties on those plants that fail to meet regulatory requirements.

Ukrainian Priorities 7 & 8: Securing regulations on physical protection and non-proliferation

Assistance in this area is provided by the U.S. government under the Comprehensive Threat Reduction Program. The NRC is assisting in this effort by supporting the development of a regulatory program as a complement to the efforts of other U.S. agencies.

The NRC has procured equipment, conducted workshops and reviewed draft documents in support of the program.

Ukrainian Priority 9: Establishing regulatory control over waste, spent fuel and other nuclear materials

The NRC is assisting in the management and disposal of radioactive waste and spent fuel. The objective is to help Ukraine in reviewing past regulations and evaluating the current situation, and to provide on-the-job training and the review of new regulatory documents.

One initial project entailed making an inventory of radioactive wastes and determining how regulatory practices have affected waste management practices. Subsequently, the NRC reviewed regulatory documents on waste management and the implications of decommissioning.

Ukrainian Priority 10: Fire protection regulations

The NRC is helping to develop and apply methodologies for regulatory review of fire protection and post-fire safe shutdown analysis.

The agency provided Ukrainian regulators with a comprehensive technical document outlining the U.S. approach to fire protection. Ukrainian regulators visited the United States for a training course on NRC licensing requirements for fire protection, which included classroom instruction and visits to nuclear plants and laboratories. Subsequent activities will be incorporated in Priority 5 activities on the development of inspection procedures.

Ukrainian Priority 11: Developing an incident response center

The NRC is helping to develop a response plan and the procedures, supporting facilities and equipment to improve Ukraine's ability to respond to emergencies at nuclear power plants. This effort includes the development of an integrated plan, formal training and an operational prototype, followed by a full-scale response system. The result will strengthen the ability of the NRA to maintain and improve the system after the project is completed.

The NRA has conducted an exercise to help refine the requirements of the emergency response center. Basic communications equipment has been installed, and duty officers have begun to work from the new location.

Ukrainian Priority 12: An incident reporting system

This project involves developing and implementing a customized system for incident reporting and experience feedback based on U.S. requirements. The purpose is to improve plant safety by providing operational trending data and analysis using probabilistic safety assessment techniques.

Training has been provided on root-cause investigations, human performance reliability and equipment reliability.

Ukrainian Priority 13: Creating a legal framework for the Ukrainian regulatory authority

The NRC has commented on draft legislation dealing with the safety regulation of the Ukrainian nuclear industry. To prepare for this assistance, NRC legal staff studied the government, political, economic and social conditions affecting the passage of nuclear legislation.

One of the objectives of the program was to develop a national law that provides a legal framework for NRA regulatory jurisdiction and provides the NRA with adequate authority. In February 1995, President Kuchma signed nuclear legislation that provides this authority.

The NRC is also commenting on other draft subsidiary nuclear laws as they are prepared.

Ukrainian Priority 14: Developing research support for regulatory activities

The NRC is helping the NRA to develop its technical capability for selected research to support regulatory activities. Included in the support are consultation and advice, training on analytical methodology and on-the-job training workshops to assist NRA staff in developing a PRA for an operating Ukrainian nuclear power plant (Rovno 1).

A plant-specific risk model has been developed and installed at Rovno Unit 1 to facilitate the assessment of risk occurring as a result of technical design modifications and technical specification changes. Reliability data has been developed and incorporated in the plant PRA model, and an interim report has been published. Plant personnel received PRA training in the United States on implementing the PRA model.

Ukrainian Priority 15: Regulating radioactive materials used in industry and medicine

The NRC is helping the NRA to develop methods for regulating radioactive sources used in industry and medicine. The purpose is to provide the NRA with information needed to establish regulatory control over these sources. To achieve this purpose, past regulations are being reviewed, the current situation in Ukraine is being evaluated and on-the-job training is being provided. The NRC has commented on several regulatory documents related to licensing.

Ukrainian Priority 16: Establishing regulations for the transportation of radioactive materials

The NRC is helping the NRA to develop the competency to regulate—and to develop appropriate regulations on—the transportation of radioactive materials and the storage of spent fuel.

The NRC has trained NRA staff on the use of regulatory codes, and has reviewed several draft regulatory documents on transportation and spent fuel prepared by the NRA with NRC assistance.

Ukrainian Priority 17: Institutional strengthening

The NRC is providing the office equipment that the NRA needs to function effectively as an organization. The project focuses on the integration of a computer network and work flow management. Virtually all the equipment agreed upon has been delivered.

Armenia

Fire Protection. In May 1995, the NRC provided training to three Armenian specialists on the history, development and implementation of the agency's fire protection-related regulations and activities. The three weeks of training included a fire protection walkdown at Duquesne Light Co.'s Beaver Valley nuclear plant near Pittsburgh, and a tour of Underwriters Laboratories—a fire protection equipment testing laboratory—near Chicago.

In December 1996, the NRC sponsored the participation of two Armenian specialists in a Department of Energy workshop on the development and conduct of fire hazards analyses in nuclear power plants. The workshop included actual fire hazards analysis walkdowns at Consolidated Edison Co.'s Indian Point nuclear plant and New York Power Authority's FitzPatrick nuclear plant.

Seismic Issues. In March 1996, the NRC provided a week of training to numerous Armenian specialists in Armenia. The training addressed the history, development and implementation of the NRC's regulations and activities related to seismic issues at operating nuclear plants. It also included a seismic-related walkdown inspection of Medzamor, the Armenian nuclear plant.

Site Security. In three sessions—one week in July 1995, one week in December 1995 and two weeks in September 1996—the NRC provided training to Armenian specialists on the history, development and implementation of the agency's site security-related regulations and activities at operating nuclear plants. The training included an overview of the NRC's site security regulations, requirements, licensing and inspection practices, and participation in actual NRC site security inspections at Florida Power & Light Co.'s Turkey Point nuclear plant (December 1995) and Pacific Gas and Electric Co.'s Diablo Canyon nuclear plant (September 1996).

Additional site security training was planned for August 1997.

Radioactive Waste and Spent Fuel Management. In October 1995, the NRC provided training to an Armenian specialist on the history, development and implementation of the agency's regulations and activities related to low- and high-level radioactive waste, spent fuel storage, and transportation of radioactive materials. The two weeks of training included a walkdown inspection of the Barnwell low-level waste disposal facility in South Carolina, a walkdown inspection of the spent fuel dry cask storage facility at Virginia Power Co.'s Surry nuclear plant, and a visit to NRC's Region II office in Atlanta.

Reactor Pressure Vessel Embrittlement. In December 1996, the NRC provided training in Armenia to numerous Armenian specialists on the agency's regulations, requirements and activities related to radiation-induced embrittlement of the reactor pressure vessel. The training included a demonstration of the methodology used by the NRC to determine actual reactor pressure vessel embrittlement. Safety issues and concerns unique to VVER-440 Model V230 reactors were also stressed.

Licensing of Previously Operating Reactors. In February 1997, the NRC provided training to an Armenian specialist on techniques and procedures used by the agency in the late 1970s and early 1980s to gauge the safety of plants licensed using earlier regulatory criteria against the safety of plants licensed using newer, revised criteria (the Systematic Evaluation Program).

Equipment. In March 1996, the NRC purchased a gasoline-powered generator for use at the Armenian Nuclear Regulatory Authority's headquarters in Yerevan. The NRC also plans to procure additional basic office equipment—e.g., computers, printers, fax machines—for the regulatory authority.

Decommissioning. In April 1997, the NRC provided two weeks of training to two Armenian specialists on the agency's regulations, methodology and approach for decommissioning nuclear power plants. The training included a visit to Yankee Atomic Electric Co.'s Yankee nuclear plant in Rowe, Mass., which is being decommissioned, and to the Barnwell low-level waste disposal facility.

Kazakhstan

Power Reactor Inspection Training. In May 1996, the NRC provided training to four Kazakh specialists on the agency's inspection program and activities with respect to operating nuclear plants. The two weeks of training included an overview of the NRC's inspection procedures and an example of a walkdown inspection at Baltimore Gas and Electric Co.'s Calvert Cliffs nuclear plant. Safety issues and concerns unique to sodium-cooled fast reactors were also stressed.

Research Reactor Inspection Training. In September 1996, the NRC provided training to eight Kazakh specialists on the agency's inspection program and activities with respect to operating research reactors. The one week of training included an overview of the NRC's inspection procedures and an example inspection at the Brookhaven National Laboratory's research reactor. Safety issues and concerns unique to Soviet-designed reactors were also stressed.

Licensing of Previously Operating Reactors. In February 1997, the NRC provided training to two Kazakh specialists on techniques and procedures used by the agency in the late 1970s and early 1980s to gauge the safety of plants licensed using earlier regulatory criteria against the safety of plants licensed using newer, revised regulatory criteria.

Demonstration Electrical Distribution System Inspection. In December 1996, the NRC sponsored a demonstration electrical distribution system function inspection at Kazakhstan's BN-350 fast breeder reactor near Aktau. The demonstration, using NRC procedures as guidelines, included the development of an inspection plan, a request for necessary design information from the plant, the actual demonstration inspection, and preparation of an inspection report. The inspection was carried out by four Kazakh inspectors and was coordinated and guided by NRC representatives.

EASTERN EUROPE

In addition to its projects for Russia and Ukraine, the NRC provides assistance to all five countries in Central and Eastern Europe with Soviet-designed reactors: the Czech Republic, the Slovak Republic, Hungary, Bulgaria and Lithuania. By and large, the NRC's objective has been to help these countries improve their ability to regulate their plants. Programs have involved in-depth training of regulatory administrators and inspectors, the exchange of technical information, and safety-analysis tools.

The first general bilateral agreement was signed in April 1989 with Czechoslovakia. A second formal bilateral agreement for assistance was signed with Hungary in September 1990.

Lithuania signed its first formal agreement with the NRC in April 1994. Renewing their assistance agreement with the NRC, the new governments of the Czech and Slovak republics signed new agreements in November 1994. Hungary signed a new agreement in September 1996. Bulgaria remains on the list of NRC assistance recipients, but has not yet signed a formal agreement.

Funding Levels

The NRC began seeking financial assistance for its Central and Eastern European programs from the U.S. Agency for International Development (AID) in late 1990. In October 1991, AID released $575,000 in funds for NRC assistance to Czechoslovakia and Hungary. In March 1992, AID amended the agreement to provide an additional $150,000 for assistance to Bulgaria.

An additional $900,000 in AID funds became available in October 1992 to fund assistance for the Czech Republic, the Slovak Republic, Hungary, Bulgaria and Lithuania. Apart from programs already in progress and supported by the 1991 budget, the 1992 AID funds were also to help finance membership by all five countries in the International Piping Integrity Research Group, a consortium of government and industry organizations that fund large-scale pipe-fracture experiments under realistic conditions.

The NRC received $1.6 million in funding for fiscal year 1993, $1.5 million for fiscal year 1994, and $1 million for fiscal year 1995. It received a total of $968,000 for fiscal years 1996 and 1997.

Program Development. Before funds were available, early NRC assistance programs in Central and Eastern Europe took shape through special visits by senior NRC representatives. With the first Czechoslovak agreement, for example, NRC personnel visited the Dukovany plant as well as the Skoda heavy machinery plant. With the advent of AID funding, however, more formal programs began to evolve. Among them:

- A nuclear safety orientation program involving discussion of a wide range of regulatory and safety issues that either U.S. or Eastern European representatives initiated. For example, summer 1992 meetings in Prague and Budapest involving Czechoslovak Federal Republic and Hungarian representatives centered on topics such as reactor vessel embrittlement and annealing, the integrity of plant piping, piping leaks and reconstruction of the older VVER-440 Model V230 plants.

By fall 1993, as many as 14 Czech, 11 Hungarian and two Slovak regulators had visited NRC headquarters in Rockville, Md., the NRC's Technical Training Center in Chattanooga, Tenn., and the Beaver Valley nuclear power plant in Pennsylvania under the safety orientation program.

- An NRC fellowship program that allows regulators from Central and Eastern European countries to see the U.S. regulatory process through NRC eyes. The program began by allowing Central and Eastern European "fellows" to work alongside NRC staff, developing work programs and taking on projects that relate to their particular regulatory interests. The first fellows—one from the Czech and Slovak Federal Republic and one from Hungary—came in June 1992 and worked at the NRC for six months.

- Legal and regulatory assistance designed to provide Central and Eastern European counterparts with a broad picture of the legal system behind U.S. nuclear regulatory systems and practices. In 1993, for example, two Hungarian regulators and one Slovak regulator received a two-week overview on such issues as the U.S. legal framework for the NRC, approaches in making rules that govern nuclear issues, ways to involve the public in the NRC's rulemaking process and the enforcement of NRC rules.

- Training in the use of NRC-developed nuclear safety computer codes in such areas as thermal-hydraulics, severe accident analysis and probabilistic risk assessment. These codes provide models by which engineers design, operate and modify nuclear power plants. Codes can, for example, offer verifiable information that engineers can reference when they want to know how certain plant components or systems behave in either normal or accident conditions. Over the years, U.S. and international engineers and regulators have developed a variety of valuable computer codes. The NRC's code program helps teach Central and Eastern European representatives how to use these codes and permits them access to user groups that are composed of experienced international representatives.

  In January 1993, for example, the NRC sponsored a two-week course for Lithuanian regulators on thermal-hydraulic codes. These codes can provide baseline information on how piping and other plant components respond to varying water temperatures and pressures. Other Central and Eastern European representatives participated in a fall 1993 week-long course in New York City on the American Society of Mechanical Engineers' boiler and pressure vessel codes and standards—equipment fabrication codes that American engineers routinely apply to the design and operation of nuclear reactor vessels.

- A nuclear inspection program intended to educate inspectors from nuclear safety bodies in the Czech Republic, the Slovak Republic, Hungary and Bulgaria about the plant inspection procedures used by the NRC. The ultimate goal: to provide inspectors in these countries with approaches they can adapt to their own programs.

The program involves two tracks: 1) a two-week course for chief inspectors and 2) a two-month course for resident inspectors who are located at the plant site. Chief inspectors received their first course offering in June 1993, and the resident inspectors in August 1993. The courses allow the visiting inspectors to work side-by-side with NRC inspectors; they provide on-the-job training in inspection practices; they include sessions at the NRC Technical Training Center in Chattanooga, Tenn.; and they allow participation in actual inspections. In September 1994, the NRC expanded the program with a two-month course offered to plant inspectors from all Eastern European countries that provided trainees for the 1993 courses.

- Assistance in regulatory rules and guidelines. This program helps Central and Eastern European countries organize their regulatory structures, review current regulatory procedures and develop new safety rules. In May 1993, for example, the NRC sponsored a month-long trip of a senior NRC specialist to Budapest, at the request of the Hungarian Atomic Energy Commission, to review Hungarian regulatory programs.

Key 1995 Activities

During 1995, the NRC continued to assist the development of effective regulatory organizations by: promoting safety culture awareness and practices, strengthening the legal framework and regulatory capabilities, improving analytic capabilities for performing safety analyses, and strengthening inspectorates through intensive training in NRC regulatory inspection philosophy, procedures and techniques.

The NRC has emphasized a regional approach by including representatives from all Central and Eastern European countries. The need to respond quickly to the recipient countries' changing assistance priorities has demanded flexibility of the agency.

Among key 1995 activities:

Regional Activities. The NRC offered a seismic margin analysis course in February in Budapest. Although Eastern European nuclear power plant operators are now carrying out a variety of safety reviews to reduce risks, they need training in state-of-the-art seismic evaluation techniques developed in the United States to cost effectively assess their actual seismic risk and/or vulnerabilities. Walkdowns of Hungary's Paks plant and the Slovak Republic's Bohunice plant were included in the course.

The NRC conducted a tutorial on risk-based regulations in March. Participants spent one week in the NRC's Office of Research, one week in the Office of Nuclear Reactor Regulation, and one week in Atlanta at NRC's Region II office. The tutorial included many meetings with NRC technical staff and a three-day course on human reliability analysis at NRC headquarters.

Through NRC sponsorship, several participants from Central and Eastern Europe attended a training course on U.S. commercial nuclear power plant fire protection practices conducted by Brookhaven National Laboratory. The training provided an understanding of NRC's requirements and the licensing and inspection practices for fire protection at U.S. commercial plants. Participants also learned about the U.S. nuclear energy industry's fire protection and post-fire shutdown practices. As part of the course, the participants toured the Beaver Valley nuclear plant and discussed fire protection features and post-fire safety shutdown design configurations. They also toured a fire test facility at Underwriters Laboratories.

In response to a request from the Slovak Republic's Nuclear Regulatory Authority for training on formal procedures for the verification and validation of computer codes to be used in analyzing VVER reactors, the NRC hired Scientech Inc. to conduct such a course at the republic's technical training center in Trnava in September. Participants from the Czech and Slovak republics, Hungary, Bulgaria and Lithuania were shown the general methodology for applying the relevant computer code, or set of codes, to VVER reactors for a given design-basis analysis. They also learned how to verify that a given code produces valid results.

NRC representatives attended the second regular meeting of the Association of the State Nuclear Safety Authorities of the Countries Operating VVER-Type Reactors, which was held in the Slovak Republic in May. Among the participants were the nuclear authority chairmen of Czech and Slovak republics, Hungary, Ukraine, the Russian Federation and Finland. Bulgaria was represented by the director of nuclear safety. Topics covered included: country reports on the safety status of nuclear facilities, information on safety significant events, illicit trafficking of nuclear and radioactive materials across state boundaries, adherence to the Vienna Convention on Nuclear Safety, and decommissioning and radwaste treatment. Four technical working groups reported on cooperative program accomplishments.

The Czech Republic. The NRC has continued to support training for the Czech regulatory authority—provided by the Idaho National Engineering and Environmental Laboratory and Lawrence Livermore National Laboratory—in evaluating the safety of the Temelin nuclear power plant (which is being backfitted with Westinghouse instrumentation and control systems and fuel) in accordance with NRC licensing procedures. The laboratories will also provide advice to the authority on how to write a final safety evaluation report as required under U.S. practices. This training effort, which began in May 1994, is expected to be completed in late 1997 or early 1998. However, because of unanticipated delays in the plant construction phase, this program is now likely to slip by about a year. A major part of the effort is devoted to the software aspects of digital instrumentation and control systems.

The Slovak Republic. The Slovak Republic's Nuclear Regulatory Authority requested assistance in planning for decontamination and decommissioning of nuclear power reactors currently operating or awaiting decommissioning. This issue is of particular importance in view of the contamination generated by the country's A-1 gas-cooled nuclear power plant that was shut down in 1976 and is due to be decommissioned. A course on decontamination and decommissioning—including formal consultation sessions with NRC staff, site visits to U.S. facilities with decommissioning activities under way (such as Fort St. Vrain), training sessions for technology transfer, and discussion of lessons learned from U.S. experience with plant decontamination and decommissioning—was held in January.

The authority also requested a one-week training assignment at NRC headquarters for its director and deputy director of international relations designed to expose them to NRC's approach to carrying out international obligations and other support functions. The training included meetings with officials from the Office of Public Affairs, Congressional Affairs, Division of Contracts, Office of the Controller, Office of the General Counsel, and the Technical Specifications Branch, as well as meetings with several country officers in the Office of International Programs.

The Nuclear Regulatory Authority opened its emergency operations center in May, and is now developing an efficient mode of operation and establishing written procedures. In light of this work, the authority's vice chairman asked to participate in an NRC emergency exercise. The vice chairman and two colleagues participated in an emergency exercise at the Wolf Creek nuclear power plant in Kansas in August. Technical staff from NRC's Region IV took the lead in hosting the training, escorted the Slovak visitors, and handled coordination efforts between the regional office and Wolf Creek plant staff.

The NRC also arranged a two-week management assessment and training course in March in Bratislava. The purpose of the course was to help the Nuclear Regulatory Authority acquire Western management and communication tools and skills to supplant the less efficient management style and techniques of the previous communist-era regime. The new skills should allow staff to cope with increased work loads and decentralized decision-making requirements resulting from the absorption and application of Western nuclear safety concepts. A similar course, taught in Prague in October 1994, was well received by the Czech participants.

Hungary. Dr. Lajos Vöröss, chief inspector at the Hungarian Atomic Energy Commission, went to the NRC under a three-week mini-fellowship for senior managers. He spent two weeks at NRC headquarters, and one week in Region IV. During this time, he learned about such subjects as NRC management techniques, organization issues and program tracking procedures.

Lithuania. Two senior NRC attorneys visited Lithuania in May to meet with representatives of the Lithuanian Nuclear Power Safety Inspectorate (VATESI). The purpose of the meeting was to discuss legal issues associated with VATESI's regulatory activities. In addition, the NRC attorneys met with members of the Lithuanian Parliament and the director of the parliamentary legal staff to discuss key aspects of a law on nuclear energy that Lithuania is drafting.

The NRC also contracted with Scientech Inc. to help VATESI in developing new Lithuanian safety norms and standards, preparing an Ignalina-specific inspection guidance manual, and developing an Ignalina systematic evaluation program.

Key 1996 Activities

The NRC continued to carry out work under the AID-funded assistance program for Central and Eastern Europe. Some recent developments are summarized below.

The Czech Republic. In early October, the NRC conducted a peer review of the progress made by the staff of the Czech State Office for Nuclear Safety (SONS) in using NRC methodology for licensing the Temelin nuclear power plant. The SONS staff demonstrated a thorough understanding of the NRC safety evaluation process and the ability to apply it properly to close out difficult safety issues associated with the licensing of digital instrument and control (I&C) equipment.

NRC contractors conducted a workshop in Prague on defense-in-depth and the diversity of digital I&C system design.

As a result of delays experienced by the Czech utility CEZ in the construction phase of work at Temelin, the NRC and SONS agreed to reschedule the training effort, which is now expected to be resumed in mid-1997.

Hungary. With AID funding for Hungary coming to an end, the pace of the NRC's direct nuclear safety assistance activities is decreasing. These activities will gradually be replaced by the type of cooperative activities that NRC engages in with other nuclear countries. To reinforce the relationship between Hungary and the United States, NRC Chairman Shirley Ann Jackson and George Vajda of the Hungarian Atomic Energy Commission used the occasion of the September IAEA General Conference to sign an extension to their information exchange arrangement.

In September, the NRC hosted a professor from the Janus Pannonius University in Hungary who was in the United States on a grant from the U.S.-Hungary Science and Technology Program. Prof. Peter Lenkei visited the NRC for discussions on seismic issues, including earthquake design and assessment of nuclear power plant structures, and regulatory guidelines for reinforced concrete structures of existing nuclear power plants.

The Slovak Republic. Jozef Misak, chairman of the Slovak Republic's Nuclear Regulatory Authority, and Stefan Rohar, the authority's chief inspector—who were in the United States to attend the American Nuclear Society/European Nuclear Society meeting—visited the NRC during their stay. In a meeting with representatives of the NRC, the Department of Energy, the State Department and other agencies, they explained the status of reactor pressure vessel integrity at the Bohunice nuclear power plant, and the confinement upgrades that had been made at the plant.

Bulgaria. As a result of the unsettled political and economic conditions in Bulgaria, regulatory assistance activities have been put on hold temporarily. Cooperation has been complicated by changes in the leadership of the Committee on the Peaceful Use of Atomic Energy. The chairman has been replaced three times since August 1996.

The NRC planned to use the occasion of an IAEA Operational Safety Review Team mission to the Kozloduy plant, scheduled for early 1997, to review the assistance needs of the Bulgarian regulatory authority and define assistance opportunities in consultation with other Western donor countries. But the mission was postponed at the request of Bulgaria, and is now expected to take place in the fall of 1997. The NRC will review its assistance options at that time.

Lithuania. The Lithuanian bilateral regulatory assistance program for VATESI—the Lithuanian regulator—is moving ahead at full speed. The work is being coordinated with, and is a part of, the overall international nuclear safety assistance effort for Lithuania that is headed by the Swedish International Program.

The NRC and its contractor have delivered to VATESI a set of modern "Norms and Standards" that are based in part on earlier Russian codes but have been appropriately augmented by IAEA and other Western regulations and practices.

The NRC also has completed and delivered to VATESI a "Regulatory Regime" policy paper. The paper spells out, among other things, how VATESI should carry out its role of regulating nuclear facilities to ensure safety, how it should interface with the Ignalina plant and government entities, and how it should make licensing decisions, carry out inspections and enforce regulations. Frequent coordination meetings among participating donor countries help ensure consistency in the treatment of material, and reduce the chances for duplication of work or gaps in coverage. In addition, the NRC has delivered a set of regulatory inspection guides to VATESI. Because of work pressure and shortage of qualified staff, VATESI has not yet put into use any of these regulatory documents.

NUCLEAR SAFETY ASSISTANCE: THE DEPARTMENT OF ENERGY'S ROLE

The U.S. Department of Energy (DOE) conducts a comprehensive, cooperative effort to reduce risks at Soviet-designed nuclear power plants. In eight partnering countries—Russia, Ukraine, Armenia, Bulgaria, the Czech Republic, Hungary, Lithuania, and Slovakia—joint projects are correcting major safety deficiencies and establishing nuclear safety infrastructures that will be self-sustaining.

The joint efforts originated from U.S. commitments made at the G-7 conference in 1992, when world leaders agreed to collaborate with host countries to reduce risks at older Soviet-designed reactors. Since that time, DOE efforts have expanded to include safety-related activities at 20 nuclear power plants with 64 operating reactors. DOE conducts the work in cooperation with similar efforts initiated by Western European countries, Canada and Japan.

DOE supports the host countries in the following efforts:

- conducting safety assessments
- improving operating procedures
- establishing training centers
- installing essential safety equipment
- establishing a culture in which safety takes priority over power production
- addressing the extraordinary problems at Chernobyl (Chornobyl).

DOE received $108 million in fiscal year 1997 for its nuclear safety assistance programs. For fiscal years 1992 to 1997, DOE received a total of $240.5 million.

Efforts in Russia

Russia has 29 operating civilian nuclear power reactors, located at nine plants. Together, these reactors provide about 13 percent of Russia's electricity.

The reactors follow four designs, with 11 RBMKs, 13 VVERs, four LWGRs, and one breeder reactor. (RBMKs are boiling-water, graphite-moderated, pressure-tube reactors; VVERs are pressurized, light-water-cooled and -moderated reactors; and LWGRs are light-water-cooled, graphite-moderated reactors.)

DOE has undertaken safety projects at the following Russian nuclear power plants: Balakovo, Beloyarsk, Bilibino, Kalinin, Kola, Kursk, Novovoronezh, Smolensk and Leningrad.

Management and Operational Safety Projects

Management and operational safety projects increase the ability of plant personnel to operate reactors safely. The projects establish procedures and standards for safe operations and transfer the most effective methods for responding to abnormal conditions, including major accidents. DOE also transfers established technologies for maintaining safety equipment. Projects are organized into five areas:

- conduct of operations
- operator exchanges
- training and simulator development
- emergency operating instructions
- maintenance technology transfer and training.

Key accomplishments through December 1996

- DOE and its U.S. contractors worked with Russian personnel to establish a training center at Balakovo. The center has developed and presented nine of 12 operations and maintenance courses and five of six specialized courses. More than 800 power plant workers now have attended courses at Balakovo and its counterpart training center in Ukraine.

- To transfer training skills to other Russian plants, DOE sponsored workshops on the Systematic Approach to Training for three months at the end of 1996. Representatives from the Kursk, Leningrad, Smolensk and Beloyarsk plants attended, as well as staff from the Smolensk Training Center.

- DOE is supporting the development of plant simulators to train control room operators. U.S.-based GSE Power Systems, Inc., (formerly S3 Technologies) and the Russian Institute for Nuclear Power Plant Operations (VNIIAES) have formed a joint venture to produce full-scope simulators for Kola and Kalinin and an analytical simulator for Novovoronezh. DOE has transferred computer and hardware devices to VNIIAES for use in developing the simulators.

- DOE and host-country specialists have completed design specifications for an analytical simulator for Balakovo.

- DOE has transferred to Russian plants the methodology for developing symptom-based emergency operating instructions. Novovoronezh has implemented the first set of 22 instructions developed for that plant. Balakovo has completed the first draft of all 48 of its instructions.

- DOE is working with Russia to reduce accidents through improved maintenance programs. DOE's maintenance technology transfer and training efforts in Russia focus on the three plants with RBMK reactors: Leningrad, Kursk and Smolensk. In 1996, DOE delivered pipe lathe/weld preparation machines to all three plants, enabling workers to cut and weld main coolant pipes with the precision necessary to prevent leaks. Previously, workers made cuts by hand.

- With DOE support, representatives from the five RBMK sites in Russia, Ukraine and Lithuania established a Maintenance Advisory Board to provide oversight and direction for maintenance technology transfer and training projects. In 1996, the Smolensk and Chernobyl plants each hosted an information exchange meeting for RBMK maintenance managers.

- Sponsored in part by DOE, 50 staff members from seven Russian plants and nuclear organizations have visited eight U.S. nuclear plants to observe and discuss U.S. safe reactor operations.

- Balakovo has implemented nine improved operational procedures. The procedures are based on 16 standard operating guidelines for Soviet-designed plants. Representatives from DOE, host-country plants, U.S. industry, and the Institute of Nuclear Power Operations (INPO) developed the guidelines, based on INPO's "good practices" standards.

Work in progress

- The Balakovo training center is preparing to teach instructors at other plants to improve training processes. U.S. and Balakovo specialists will conduct training needs assessments at Russian plants.

- Two Russian design organizations, Gidropress and RDIPE, are developing the technical basis calculations needed to implement symptom-based emergency operating instructions.

- Balakovo training center staff are developing the remaining pilot training courses.

- DOE is transferring additional maintenance technologies to plants with RBMK reactors. These include vibration monitoring and shaft alignment systems, valve-seat resurfacing equipment and infrared thermography equipment. U.S. experts train maintenance workers to use the equipment before it is delivered to each plant. DOE also will provide a thermo-mechanical training loop to give workers hands-on experience in maintaining mechanical, electrical and instrumentation-control systems.

- U.S. and host-country experts are establishing a databank of technical information for maintaining Soviet-designed reactors. At RBMK sites, DOE will supply computers and a satellite communication system so staff members can access the databank, discuss problems and share information.

- With DOE funding, work is under way to refurbish and equip training rooms at RBMK sites and the Smolensk Training Center.

Engineering and Technology Projects

DOE is working with Russian personnel on the following engineering and technology projects:

- upgrading fire safety and radiation confinement systems
- performing fire hazards analyses
- installing back-up power systems
- transferring mobile pumping units for emergency water supplies
- developing safety parameter display systems
- developing indigenous capabilities to manufacture safety equipment that meets international requirements.

Key accomplishments through December 1996

- U.S. experts and host-country specialists developed the *Reactor Core Protection Evaluation Methodologies for Fires at RBMK and VVER Nuclear Power Plants.* The guidelines enable analysts to assess fire hazards and identify which changes in procedures and equipment will be most effective in preventing fires and reducing the risk of damage to the reactor core. The text will be issued in English and Russian.

- DOE has delivered fire-retardant materials to Smolensk to coat cables and seal the room-to-room penetrations through which electrical cables pass. The cables had been covered with a material designed to be fireproof but which proved combustible. DOE also has provided a set of fire detectors and 80 units of a self-contained breathing apparatus for Smolensk firefighters.

- After receiving training from U.S. specialists, Atomremmash, a Russian company, has manufactured 400 fire doors for the Smolensk plant. International inspectors have certified the doors.

- U.S. experts have worked with Kola staff to seal leaks in the radiation confinement system, install confinement isolation valves in the ventilation piping and set up a post-accident radiation monitor to trigger the valves.

- The Kursk plant has received hand-held ultrasonic test equipment for detecting leaks in the piping of reactor coolant systems. U.S. experts have trained workers to use it. DOE also will provide an automated ultrasonic test system for use in areas that are inaccessible to workers while the reactor is operating.

- Kola workers have installed safety-grade direct-current batteries at reactor Units 1 and 2, along with switchboards and seismically qualified racks. DOE has delivered similar batteries to the Kursk plant. The batteries provide backup power to control and safely shut down a reactor during an emergency. They replace systems that were unreliable, hazardous to recharge and vulnerable to earthquake damage.

- Kursk has received an emergency water-supply system with a mobile pumping unit.

- Workers at the Leningrad plant have installed a fire-detection system in reactor Unit 1.

Work in progress

- U.S. experts are providing fire-hazards evaluation training.

- U.S. experts are teaching Russian plant managers to develop plant regulations based on safe-shutdown methodologies.

- Plans are under way to ship more fire detectors and a fire-brigade radio system to Smolensk.

- U.S. and Russian specialists are developing an emergency water-supply system for Novovoronezh.

- Westinghouse Electric Corporation is collaborating with RDIPE to develop safety parameter display systems for RBMK reactors. The systems collect and display critical safety information at a workstation in the control room, enabling operators to assess plant conditions rapidly and take quick corrective action. Development of a pilot system for Kursk Unit 2 is under way. Nine more RBMK reactors will receive display systems.

- U.S.-based Science Applications International Corp. is collaborating with ConSyst, a Russian company, on display systems for VVER-440/230 reactors. Russia's Novovoronezh Unit 3 will be the first to receive a system.

Plant Safety Assessments

U.S., international and host-country specialists are conducting in-depth safety assessments at three Russian plants to determine the most significant risks and set priorities for safety upgrades. Activities to support the assessments include the following:

- probabilistic and deterministic risk analyses
- transfer of safety analysis computer codes
- validation of codes
- training in the use of new codes
- performance of plant-specific safety assessments.

U.S. contractors are training Russian specialists in safety analysis methodologies and the use of RELAP5 and other computer codes. The contractors also work with the specialists at their plants to develop computer models and perform analyses. When these tasks are accomplished, Russian specialists will assess the safety of their own reactors, determine the most significant risks and identify the most effective safety upgrades.

Key accomplishments through December 1996

- DOE's Argonne National Laboratory has designed a database for use in performing safety assessments. The database, which includes plant-specific information for Soviet-designed reactors, is available on the Internet at http://www.insc.anl.gov.

- The Nuclear Safety Institute of the Russian Academy of Sciences updated a generic description of Soviet-designed VVER reactors, entitled *Overall Plant Design Description: VVER, Water-Cooled, Water-Moderated, Energy Reactor*. Known as the "Redbook," it supports safety assessments.

Work in progress

- U.S., Finnish and Russian personnel are conducting a safety assessment at Kola. The team has completed a thermal-hydraulic model of the plant.

- U.S., Swedish, British and Russian specialists are conducting a safety assessment at Leningrad. The team has completed a thermal-hydraulic model of the plant.

- U.S. and Russian specialists are developing project guidelines to continue an assessment at Russia's Novovoronezh plant.

- U.S. experts are working with Russian specialists to study the containment buildings surrounding Soviet-designed VVER-1000 reactors and develop recommendations to improve their ability to withstand pressure caused by steam buildup after a large pipe break.

Nuclear Safety Institutional and Regulatory Framework

DOE is supporting the development of a strong legal framework for the regulation of Soviet-designed nuclear power plants. This work is coordinated closely with the U.S. Nuclear Regulatory Commission.

The legal framework will promote:

- Adherence to international nuclear safety treaties and liability conventions. Such adherence promotes the effective exchange of information and technology during nuclear programs, consistent with internationally recognized safety, environmental and health standards.

- Domestic protection from liability for nuclear-related malfunctions or accidents. Such laws will permit more extensive use of advanced safety technology.

- Establishment of strong, independent regulatory bodies with the capabilities to regulate nuclear activities.

Key accomplishments through December 1996

- Representatives from Gosatomnadzor (GAN), the Russian nuclear regulatory organization, have received training in the United States on emergency preparedness.

- GAN representatives have participated in workshops on quality assurance and safety analysis for research reactors and fuel-cycle facilities.

Special Studies

Leningrad's Unit 1 reactor is approaching the end of its useful life. Russian regulatory representatives and plant mangers have requested DOE assistance in studying decommissioning options. A U.S.-Russian team is identifying the regulatory and technical plans needed to develop a safe, technically feasible decommissioning strategy.

The team has begun identifying legislative requirements and analyzing existing decommissioning efforts at Leningrad.

Efforts in Ukraine

Ukraine has 14 operating nuclear reactors, located at five plants. One is an RBMK. The others are VVER models, with two VVER-440/213s and 11 VVER-1000s. The reactors provide nearly 44 percent of Ukraine's electricity.

DOE is working with Ukraine to correct major safety deficiencies at the plants and establish a self-sustaining safety infrastructure. In addition, DOE is working with Ukrainian and international experts to address the extraordinary problems at Chernobyl (Chornobyl), site of the devastating 1986 nuclear accident.

DOE has undertaken safety projects at the following Ukrainian plants: Chernobyl, Khmelnitskiy (Khmelnytskyy), Rovno (Rivne), South Ukraine and Zaporozhye (Zaporizhzhya).

Management and Operational Safety Projects

Management and operational safety projects increase the ability of plant personnel to operate reactors safely. The projects establish procedures and standards for safe operations and transfer the most effective methods for responding to abnormal conditions, including major accidents. DOE also transfers established technologies for maintaining safety equipment. Projects are organized into five areas:

- Conduct of operations

- Operator exchanges
- Training and simulator development
- Emergency operating instructions
- Maintenance technology transfer and training.

Key accomplishments through December 1996

- DOE and Ukrainian experts worked together to establish a training center at Khmelnitskiy, which has developed and presented four of eight operations and maintenance courses and three of four specialized courses. More than 800 power plant workers now have attended courses at Khmelnitskiy and its counterpart training center in Russia. Khmelnitskiy's full-time instruction staff has increased from three to 19.

- Training personnel from Khmelnitskiy have received extensive instruction on the Systematic Approach to Training methodology.

- DOE is supporting the development of plant simulators to train control room operators. U.S.-based GSE Power Systems, Inc., (formerly S3 Technologies) provided a year of simulator training to specialists from the Khmelnitskiy plant and the Ukrainian State Committee on Nuclear Power Utilization (Goskomatom). The training led to the creation of a team to develop and maintain simulators for other nuclear power plants in Ukraine. The team is based in Kiev at the Engineering Technical Center for Personnel Training for Nuclear Energy. DOE has provided computer training and computers and other equipment for the Technical Center.

- The Technical Center's specialists are supporting GSE's work on a full-scope simulator for Khmelnitskiy. Installation of control panels is under way. GSE has shipped the computer complex, input-output devices and power distribution center required for the software/hardware integration.

- The Technical Center and GSE also are collaborating on full-scope simulators for Rovno Unit 3 and South Ukraine Unit 1.

- GSE is developing a full-scope simulator for South Ukraine Unit 3.

- Construction of a simulator building at the Khmelnitskiy training center is nearly complete.

- DOE has transferred to Ukrainian plants the methodology for developing symptom-based emergency operating instructions. Zaporozhye has drafted its complete set of 48 instructions. Rovno has drafted 19 of its 38 instructions.

- Sponsored in part by DOE, 42 staff members from three Ukrainian plants have visited six U.S. nuclear plants to observe and discuss U.S. safe reactor operations.

- Zaporozhye staff have implemented 12 improved operational procedures. The procedures are based on 16 standard operating guidelines for Soviet-designed nuclear power plants. Representatives from DOE, host-country plants, U.S. industry, and the Institute of Nuclear Power Operations (INPO) developed the guidelines, based on INPO's "good practices" standards. Goskomatom has approved and issued six of the 16 final guidelines for Ukrainian plants to use in developing their own procedures.

Work in progress

- Specialists from the Engineering Technical Center and the Khmelnitskiy training center are preparing to teach instructors at other plants to improve training processes.

- Khmelnitskiy training center staff are developing the remaining pilot training courses.

Engineering and Technology Projects

DOE is working with Ukrainian personnel on the following engineering and technology projects:

- upgrading fire safety and radiation confinement systems
- performing fire hazards analyses
- installing back-up power systems
- transferring mobile pumping units for emergency water supplies
- developing safety parameter display systems
- developing indigenous capabilities to manufacture safety equipment that meets international requirements.

Key accomplishments through December 1996

- U.S. experts and host-country specialists developed the *Reactor Core Protection Evaluation Methodologies for Fires at RBMK and VVER Nuclear Power Plants.* The guidelines enable analysts to assess fire hazards and identify which changes in procedures and equipment will be most effective in preventing fires and reducing the risk of damage to the reactor core. The text will be issued in English and Russian.

- DOE has provided fire-retardant materials at Zaporozhye to coat cables and seal the room-to-room penetrations through which electrical cables pass. DOE also has provided to Zaporozhye 50 sets of fire brigade gear, 260 fire and smoke detectors, and other fire equipment, including 1,200 sprinkler heads.

- Ukrainian companies are under contract to deliver fire extinguishers to Zaporozhye, as well as 300 units of a self-contained breathing apparatus for firefighters.

- After training from U.S. specialists, Asken Ltd., a Ukrainian company, has completed the manufacture of 125 fire doors for Zaporozhye. International inspectors have certified the doors.

Work in progress

- U.S. experts are providing fire-hazards evaluation training.

- U.S.-based Burns & Roe is developing safety parameter display systems for VVER-1000 reactors in Ukraine. The systems collect and display critical safety information at a workstation in the control room, enabling operators to assess plant conditions rapidly and take quick corrective actions. The systems will be installed at Rovno, Khmelnitskiy, South Ukraine and Zaporozhye.

Fuel-Cycle Safety Projects

Fuel-cycle safety work in Ukraine has focused on providing a dry cask spent fuel storage system for Zaporozhye, which is running out of space in its storage pools for spent fuel.

Key accomplishments through December 1996

- Duke Engineering and Services has delivered cask liners, rebar and forms to build three casks. The company also has delivered a self-propelled transporter to move filled casks from the loading area to concrete storage pads.

- Duke is training staff at Zaporozhye to manufacture an additional 12 casks per year.

- U.S. experts have provided instruction in the safe use and monitoring of dry-cask systems. Zaporozhye staff have observed cask loading at the Palisades Nuclear Plant in Michigan.

- U.S. and Ukrainian experts worked together to develop cask-system operating procedures tailored to specific conditions at Zaporozhye.

- DOE has transferred U.S.-developed computer codes for storage system calculations to the Ministry of Environmental Protection and Nuclear Safety of Ukraine, the country's nuclear regulatory agency. Ukrainian regulators received courses in use of the computer codes and in the regulation of spent fuel transportation.

Work in progress

- Duke is preparing to ship the first of three sealed baskets designed to hold spent fuel assemblies inside the casks. This will complete the transfer of equipment.

- Zaporozhye staff have poured a mockup concrete storage cask in preparation for pouring actual casks and the concrete storage pads.

Plant Safety Assessments

U.S., international and host-country specialists are planning in-depth safety assessments at two Ukrainian plants to determine the most significant risks and set priorities for safety upgrades. Activities to support the assessments include the following:

- probabilistic and deterministic risk analyses
- transfer of safety analysis computer codes
- validation of codes
- training in the use of new codes
- performance of plant-specific safety assessments.

U.S. contractors are training Ukrainian specialists in safety analysis methodologies and the use of RELAP5 and other computer codes. The contractors will work with the specialists at their plants to develop computer models and perform analyses. When these tasks are accomplished, Ukrainian specialists will assess the safety of their own reactors, determine the most significant risks and identify the most effective safety upgrades.

Key accomplishments through December 1996

- DOE's Argonne National Laboratory has designed a database for use in performing safety assessments. The database, which includes plant-specific information for Soviet-designed reactors, is available on the Internet at http://www.insc.anl.gov.

Work in progress

- U.S. and Ukrainian specialists are planning assessments at the Khmelnitskiy and Zaporozhye plants.

Initiatives at Chernobyl

The Chernobyl plant has four RBMK reactors, only one of which is operating.

In 1986, Chernobyl's Unit 4 reactor exploded, destroying the reactor core. The explosion and subsequent fires dispersed large amounts of radioactive material. Left in the ruined reactor are 190 metric tons of highly radioactive uranium.

To halt the ongoing spread of contamination, workers rushed to enclose the reactor with a massive steel and concrete structure. This 20-story "shelter" is deteriorating and has developed cracks and holes. Water has collected inside and is turning the uranium into radioactive dust, which endangers workers and can escape through the shelter's holes. The shelter itself is unstable and could collapse in an earthquake or tornado.

In 1991, Chernobyl Unit 2 was shut down after a serious turbine building fire.

In 1995, Ukraine signed a memorandum of understanding with the G-7 countries to close the Chernobyl plant by the year 2000. Chernobyl Unit 1 was closed in November 1996.

Chernobyl Unit 3 continues to operate, providing urgently needed electricity for Ukraine.

Along with other G-7 countries, the United States has undertaken projects to remediate current risks at Chernobyl, alleviate the socioeconomic impacts of Chernobyl's closure and upgrade the crumbling shelter around Unit 4.

The United States also has collaborated with Ukraine to establish the Chernobyl Center for Nuclear Safety, Radioactive Waste and Radioecology. Located in the city of Slavutich, near Chernobyl, the center's primary objectives include:

- Develop in Ukraine an indigenous expertise in safe nuclear plant operation
- Provide safety support to all nuclear power plants in Ukraine
- Provide a focal point for international cooperation in addressing the environmental, health and safety issues created by the Chernobyl disaster
- Reduce the socioeconomic impacts of closing the Chernobyl plant by helping to create a new economic base for the area and employing some of Chernobyl's nuclear experts.

Key accomplishments through December 1996

The Chernobyl Center for Nuclear Safety, Radioactive Waste and Radioecology

Experts at the Chernobyl Center are collaborating with U.S. and international specialists on several technical projects:

- Experts are assessing the hazard of collapse of the shelter around the ruined Unit 4 reactor.
- Staff at the center are characterizing the condition of spent nuclear fuel at all Ukrainian power plants and developing safe options for spent fuel management.
- DOE is transferring technology for the center's nuclear data analysis project, including computers, software and reactor analysis codes for performing reactor physics and particle transport calculations. The computer capabilities also will enable the center's specialists to access the databases of partnering organizations in other countries.
- DOE has installed a satellite-based communication system at the Chernobyl Center. Previously, unreliable telephone service hindered work on joint projects. The new microwave system provides a direct

connection between the center and DOE sites for voice, fax and high-speed data transfer.

Work in progress

- In coordination with Chernobyl plant staff, specialists from DOE and the Chernobyl Center have begun evaluating the requirements for deactivation, decontamination and decommissioning of reactor Units 1, 2 and 3.

Key accomplishments through December 1996

Addressing current risks at Chernobyl

DOE’s risk-remediation projects at Chernobyl include staff training, fire safety upgrades and improvements in plant maintenance and operational safety procedures. These activities will not extend the operating life of the reactors and are consistent with plans to close the plant.

- Chernobyl managers established a group to develop technical training projects for plant personnel. In 1996, group members attended a four-week course in the Systematic Approach to Training. U.S. specialists have worked with the group to develop courses for control room operators and radiation protection personnel.
- Staff from DOE and U.S.-based Ciel Consultants, Inc., have presented the first of three quality assurance training courses at Chernobyl.
- GSE Power Systems, Inc., (formerly S3 Technologies) is developing an analytical control room simulator for Chernobyl Unit 3.
- Nineteen Chernobyl staff members have participated in operator exchange visits to the United States. Other staff members have traveled to the United States in conjunction with specific safety projects.
- Chernobyl managers have created a team to draft symptom-based emergency operating instructions for the plant. Experts from DOE and Ciel Consultants have worked with the team to develop five draft instructions. DOE has delivered computer equipment for instruction development. Ciel personnel have conducted a seminar at Chernobyl in instruction validation and verification.
- With DOE support, representatives from Chernobyl and other RBMK plants established a Maintenance Advisory Board to provide oversight and direction for maintenance technology transfer and training projects. Two information exchange meetings for RBMK maintenance managers took place in 1996—at Russia’s Smolensk plant and at Chernobyl’s business offices in Kiev.
- In 1996, DOE delivered pipe lathe/weld preparation machines to Chernobyl, enabling workers to cut and weld main coolant pipes with the precision necessary to prevent leaks. Previously, workers made cuts by hand.

- Asken Ltd., a Ukrainian company, began manufacturing 250 fire doors for Chernobyl. Asken developed its expertise through DOE training and technology transfer.

Work in progress

- U.S. specialists are working with Chernobyl staff to establish improved, written procedures for routine operations. The team has drafted six procedures and submitted them to Chernobyl's chief engineer for review.

- DOE is preparing to ship an engraver for labeling essential safety equipment, particularly valves and switches involved in carrying out emergency operating instructions. Currently, much of the plant's equipment is unlabeled, increasing the risk of operator error.

- DOE is transferring maintenance technologies to Chernobyl and other RBMK sites. These include vibration monitoring and shaft alignment systems, valve-seat resurfacing equipment and infrared thermography equipment. U.S. experts are training maintenance workers to use the equipment before it is delivered to each plant. DOE also will provide a thermo-mechanical training loop to give workers hands-on experience in maintaining mechanical, electrical and instrumentation-control systems.

- U.S. and host-country experts are establishing a databank of technical information for maintaining Soviet-designed reactors. At Chernobyl, DOE will supply computers and a satellite communication system so staff members can access the databank, discuss problems and share information.

- With DOE funding, work is under way to refurbish and equip training rooms at Chernobyl.

- On behalf of DOE, Bechtel Power Corp. has obtained bids on fire protection items for Chernobyl, including fire and smoke detectors and firefighting equipment. Through Asken Ltd., Bechtel is purchasing a fire-resistant material to coat the plant's electrical cables and structural steel.

- Chernobyl workers are applying a fire-retardant sealant material supplied by DOE. The sealant creates a barrier in the room-to-room penetrations through which electrical cables pass. Workers also will apply fire-resistant floor-coating material to concrete floors at the plant to replace a vinyl floor covering that is combustible.

- U.S., Ukrainian and Russian experts are developing a safety parameter display system for Chernobyl Unit 3.

Key accomplishments through December 1996

Upgrading the shelter around Chernobyl Unit 4

- In 1996, experts from DOE national laboratories and six U.S. corporations joined the European Commission Shelter Project, which is planning strategies for upgrading the enclosure surrounding the destroyed reactor Unit 4.

- U.S. experts examined shelter conditions and worked with Ukrainian officials to identify the most pressing needs for protection of workers monitoring the shelter. They recommended the use of worker shielding and the addition of structural reinforcement to the roof and walls in order to stabilize the shelter.

Work in progress

- The U.S. team is providing technical support to the European Commission Shelter Project in three areas: fuel removal technology, cost analysis, and monitoring.

- U.S. efforts are under way to reduce the immediate risks of working at the shelter. The U.S. team is addressing four urgent needs: radiation dose reduction, nuclear criticality assessment, dust suppression and reduction of industrial risks.

Central and Eastern European Countries

Key accomplishments through December 1996

- DOE has delivered thermal imaging hardware to Bulgaria's Kozloduy plant, enabling personnel to check for hazardous hot spots in the plant's electrical systems.

- Kozloduy instructors trained by specialists from General Physics Corporation and Sonalysts, Inc., have presented courses for shift supervisors and reactor repair technicians.

- DOE completed the delivery of essential fire protection equipment and a backup power generator to Kozloduy in 1994.

- Representatives from the United States, the Czech Republic's Nuclear Research Institute and Slovakia's Nuclear Power Plant Research Institute have signed task orders for providing technical basis calculations for symptom-based emergency operating instructions for VVER-440/213 reactors.

- Experts from the Czech Republic and U.S.-based Science Applications International Corp. completed a Level 1 probabilistic risk analysis of the Dukovany plant. The analysis identifies conditions that could damage the reactor fuel core. As a result, plant staff have modified some operating requirements to reduce the likelihood of these conditions occurring.

- In 1996, specialists completed a "Human Factors Training and Support Project" at Hungary's Paks Training Center. The Hungarian Institute for Electric Power Research now is improving training after evaluating the performance of operators on control room simulators. A team of specialists from the Czech Republic and U.S.-based Scientech, Inc., developed the project. DOE supplied a bar-code reader system, developed by Scientech, that automates the training evaluations, allowing instructors to enter evaluation codes in a computerized database with speed and accuracy.

- Lithuania’s Ignalina plant received an urgently needed pipe lathe/weld preparation machine for replacing corroded coolant-system pipes. The machine enables workers to cut and weld the pipes with the precision necessary to maintain pipe integrity and prevent leaks that could lead to a loss-of-coolant accident. Previously, workers made cuts by hand. Ignalina’s request for the equipment prompted DOE to provide the machines to all plants with RBMK reactors.

- With DOE support, representatives from the RBMK sites in Lithuania, Russia and Ukraine established a Maintenance Advisory Board to provide oversight and direction for maintenance technology transfer and training projects. Maintenance managers from Lithuania’s Ignalina plant attended two 1996 information exchange meetings.

- Ignalina specialists have drafted a complete set of five symptom-based emergency operating instructions.

- The *Ignalina Plant Parameter Source Book* documents descriptions of reactor safety systems. Available in English and Lithuanian, the book is the best source of data on RBMK-1500 reactor safety systems.

Ongoing Efforts in Armenia

Armenia’s two nuclear power reactors were shut down after a major earthquake in 1988. Armenia restarted reactor Unit 2 in 1995 and in 1996 began working on cooperative safety projects with the U.S. Department of Energy, the European Community and Russia. The Armenia Nuclear Power Station’s operating VVER-440/230 reactor provides nearly 37 percent of the nation’s electricity.

Work in progress

- Representatives from DOE and contractor Burns & Roe are working with plant personnel to reduce fire risks. The United States will provide fire-resistant floor coating, fire-resistant doors and fire and smoke detectors.

Ongoing Efforts in Bulgaria

Bulgaria’s Kozloduy plant has six operating reactors that provide about 42 percent of the country’s electricity. Four of the reactors are VVER-440/230s. The others are VVER-1000s.

Work in progress

- A team has completed the first phase of a seismic evaluation for the building that houses electrical equipment for Kozloduy units 5 and 6. The study showed certain structural supports could fail, potentially interrupting electrical service to the reactors or turbine buildings. The team, which includes specialists from DOE's Pacific Northwest National Laboratory, U.S.-based Gilbert/Commonwealth, and the Bulgarian company Risk Engineering, Ltd., will recommend measures to strengthen the structural supports and anchor the equipment.

- U.S. experts are working with host-country personnel to upgrade control room simulators at Kozloduy.

- Kozloduy personnel have completed 11 of 16 site-specific procedures for improved management and operational controls.

- Kozloduy specialists have completed the first draft of four of 48 symptom-based emergency operating instructions for the plant's VVER-1000 reactors and the first draft of 12 of 32 instructions for the plant's VVER-440/230 reactors.

- Experts from Bulgaria and DOE's Brookhaven National Laboratory are collaborating on a risk-factor analysis for Kozloduy. The team is developing two plant analyzers for use in the risk analysis, one for Unit 3, a VVER-440/230 reactor, and one for Unit 6, a VVER-1000 reactor. Experts will use the analysis in writing symptom-based emergency operating instructions for the reactors.

Ongoing Efforts in the Czech Republic

Four operating VVER-440/213 reactors at the Czech Republic's Dukovany plant provide nearly 29 percent of the nation's electricity. Two more reactors are under construction at a second site, called Temelin.

Work in progress

- Science Applications International Corp. is working with Czech specialists to determine the effectiveness of Dukovany's system for confining radioactive materials.

- Dukovany personnel have completed 13 of 16 site-specific procedures for improved management and operational controls.

Ongoing Efforts in Hungary

Four operating VVER-440/213 reactors at the Paks plant provide nearly 41 percent of Hungary's electricity.

Work in progress

- Paks personnel have completed 11 of 16 site-specific procedures for improved management and operational controls.

- U.S. and Paks experts are studying the ability of Paks' confinement structures to withstand energy created in a blowdown. A blowdown occurs when excessive heat or pressure causes a water pipe to break. The released steam will carry radionuclides if the blowdown involves pipes that carry reactor cooling water. If necessary, the team will recommend improvements to the structure.

Ongoing Efforts in Lithuania

Lithuania's Ignalina plant has the world's two largest operating nuclear power reactors. The RBMK-1500s each can produce 1,500 megawatts of electricity. Together, they provide almost 86 percent of the nation's electricity.

Work in progress

- Scientech has contracted to manufacture new instrumentation-control modules to replace aging, unreliable ones at Ignalina. Scientech also will train personnel from a Lithuanian electronics firm to manufacture additional modules. U.S. specialists will train Ignalina personnel to conduct quality assurance evaluations for the modules.

- DOE is transferring essential maintenance technologies to plants with RBMK reactors, including Ignalina. These include vibration monitoring and shaft alignment systems, valve-seat resurfacing equipment and infrared thermography equipment. U.S. experts are training maintenance workers to use the equipment before it is delivered to each plant. DOE also will provide a thermo-mechanical training loop to give workers hands-on experience in maintaining mechanical, electrical and instrumentation-control systems.

- U.S. and host-country experts are establishing a databank of technical information for maintaining Soviet-designed reactors. At Ignalina and other RBMK sites, DOE will supply computers and a satellite communication system so staff members can access the databank, discuss problems and share information.

- With DOE funding, work is under way to refurbish and equip training rooms at Ignalina and other RBMK sites.

- The Lithuanian Energy Institute is using a nuclear plant analyzer to predict heat and flow conditions that could affect safety. U.S. and Lithuanian specialists are characterizing nuclear fuel behavior in Ignalina's reactors.

- Ignalina personnel have completed 11 of 16 site-specific procedures for improved management and operational controls.

Ongoing Efforts in Slovakia

The Bohunice plant in Slovakia has four operating reactors that provide about 50 percent of the nation’s electricity. Two are VVER-440/230 reactors; two are VVER 440/213s. Four more reactors are under construction at a second site, called Mochovce.

Work in progress

- U.S. experts are providing technical assistance to upgrade Bohunice’s instrumentation-control systems so a safety parameter display system can be added. A display system collects and displays critical safety information at a workstation in the control room, enabling operators to assess plant conditions rapidly and take quick corrective actions.

- Bohunice personnel are studying the ability of the confinement structures around reactor Units 3 and 4 to withstand energy created in a blowdown. A blowdown occurs when excessive heat or pressure causes a water pipe to break. The released steam will carry radionuclides if the blowdown involves pipes that carry reactor cooling water. To support the study, U.S. specialists have taken computer codes used for calculations in a similar study at Hungary’s Paks plant and adapted them for use at Bohunice.

- Working with U.S. specialists, Slovakia’s Trnava Training Center identified training needs for the center and the Bohunice plant. U.S. experts have provided initial courses in instructor training, including the methodology of the Systematic Approach to Training. The team now is developing training courses for Trnava.

- U.S. experts are working with host-country personnel to upgrade control room simulators at Trnava.

- Personnel at Slovakia’s Bohunice plant have completed eight of 16 site-specific procedures for improved management and operational controls.